EDITORIAL

WELL, was July 1 as bad as you expected it would be?

ALEXANDER POPE once said, "I lisped in numbers, for the numbers came." Evidently he had had no experience with telephone strikes.

IF anyone needs scrap in the future, all he will need to do is to go to the Kiel canal and employ a diver. There is no more 'scrap' left in Germany, that can be stated definitely.

"IT is not a function of any branch of the Government to promote trade unions." This is an authorized statement appearing over the signature of Mr. W. B. Wilson, Secretary of Labor.

OUR old friend, Doctor Cook, has emerged from the obscurity in which he has been living since that little North Pole affair, and has blossomed out as the president of an oil company in Texas. By a curious coincidence, the treasurer is from Missouri.

AERIAL mail-service between New York and Washington during the first year of operation showed a good profit. Cost of operation per mile of flight was $0.89, divided as follows: overhead (an approximate term), $0.28; flying, $0.20; and maintenance, $0.41.

BY a typographical error, the line reading "The Monarch Co. of Stockton has a one-ton" was omitted at the top of page 247 of our June issue in the article on the Heroult furnace. The mistake was particularly unfortunate, as it affected the sense of the paragraph and in fact the entire article.

'NOBODY loves a fat man', not even an aviator. Recently, a worthy citizen of Los Angeles made arrangements to travel by aeroplane to a convention in Oakland. All went well until the pilot learned that his prospective passenger weighed 250 pounds, which, apparently, is over the safe limit for this kind of joy-riding. A lighter passenger was substituted and the journey was made without incident.

STATISTICS regarding the proportion of foreign-born residents over 10 years old and unable to speak English have recently been compiled by a Government bureau for 36 of the principal cities of the United States. The figures are taken from the 1910 census. The proportion ranges from 4.1% in Jacksonville to 35.4% in Milwaukee. San Francisco is near the head of the list with 9537 persons or only 7.4% of the total number of foreign-born over 10 years of age unable to speak English. These percentages are taken as an indication of the amount of Americanization accomplished so far and still remaining to be done, although many people, both foreign-born and native, learn the language without being Americanized, while others among our foreign-born become Americans at heart long before they have acquired even the simplest vocabulary. Creditable by comparison as San Francisco's showing is, there is evidently much more to be done. A community where approximately 10,000 people cannot even speak the language of the country has yet to take the first step toward becoming really homogeneous.

THE X-ray, which has told us so much about what was wrong with our own insides, seems likely to have its field extended to the solution of metallurgical problems. At a recent meeting of the Faraday Society of London, at which Sir Robert Hadfield presided, progress in this work was summarized. Special equipment has been devised that is capable of taking photographs through four inches of steel, and it is believed that this can be increased materially. A hole 1/64 inch diameter and of the same depth drilled in a two-inch block of steel will show distinctly in a good radiograph with an exposure of two minutes. This method can be used successfully to detect flaws and cavities, as well as the 'flakes' sometimes found in steel. Other experimenters have been able to discover faulty welds in iron ½-inch thick. In fact, it seems entirely probable that the X-ray will soon be used to supplement other tests of metallic materials, particularly for uses where soundness is essential. In many cases where a high factor of safety is used in design, the factor is made particularly high because, even when all the ordinary tests of the material have been made, there is still some doubt as to the soundness of each individual piece. If this doubt can be entirely removed by the use of the X-ray, the way is open to greater economy in design.

THAT even the most remarkable exploit soon becomes tame was illustrated by the relatively small interest in the crossing of the Atlantic by Captain John Alcock and Lieutenant Arthur W. Brown, as compared with that in the trip of the NC-4 less than a month earlier. However, this, while not the first aerial crossing of the Atlantic, was the first non-stop crossing, and also the longest non-stop flight of any kind to date. These honors America must yield to Great Britain. However, it is interesting to note that Lieutenant Brown, while an officer in the British army, is the son of American parents and renounced his American citizenship only when the War broke out in order to enter the Army.

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Peace Approaches

As was generally expected, the Germans ran true to form, keeping up their protestations until the last possible moment and then sullenly announcing that they would sign the treaty. Another indication that adversity has not essentially changed the German nature, particularly its savage pleasure in wanton destruction is found in the sinking of the surrendered German fleet on the flimsiest and most transparent of pretexts. The treaty will probably have been signed by the time this reaches our readers, and its ratification by the various Allied Powers and by the United States should follow soon afterward. In this connection, it might be remarked that the position of certain members of the United States Senate is somewhat analogous to that of the Germans. They know that the Senate is obliged to ratify the treaty. While President Wilson may not always have followed the wisest course during the past few months, in this particular question he has the tremendous advantage over his Senatorial opponents of being right, and furthermore, of having the backing of the great majority of the people. When it comes to a showdown, at least two-thirds of the members of the Senate will be found to be shrewd enough politicians to appreciate this fact.

Radicals Losing Ground

Indications are multiplying that the radical element, which has made so much trouble in industrial circles during the past year or so, is being forced to loosen its grip on certain labor organizations. This has been shown not only at the Atlantic City convention of the American Federation of Labor, but throughout the country, including the San Francisco Bay district. The results of the movement for a general strike on behalf of Thomas Mooney are typical. This was a particularly vicious general-strike plan because it had for its object interference with the orderly administration of the law. At this writing no definite statistics are available regarding the unions that have voted to strike, but we may reasonably say when July 4 comes, the general strike will be so far from being general that most of us, inured as we have become to strikes, will hardly notice it. Particularly significant is the action of the local machinists' union, which has not recently been distinguished for calm constructive action, and of which Edward Nolan, one of the original defendants in the bomb case, is an officer. The first vote showed a small majority against striking. As frequently happens when the rank and file of a union refuse to follow the wishes of radical officials, this vote was disregarded and another ballot taken. This time the vote against striking doubled, while the vote in favor was actually smaller. Returning sanity is shown by the reorganization of the Shipyard Laborers' Union of Oakland. The old officers, who called a strike two or three months ago, in defiance of the Iron Trades Council, have been expelled and a ruling has been made that no man shall be eligible for membership unless he is an American citizen or has declared his intention to become one.

Engineering Standards Association

In another column appears a statement regarding the American Engineering Standards Committee, which did such important work during the War, and which has now been reorganized as the American Engineering Standards Association. Standardization of products, whether applied to breakfast cereals or to pig-iron, is one of the most important aids to economical and efficient production. Yet if two or more organizations attempt standardization independently, the result may be worse than if no standards at all are adopted. For instance, an organization of producers and one of consumers may both attempt to prepare standards for a certain article, and may, because of difference in points of view, prepare different standards, while, if some central co-ordinating organization exists, the differences in specifications can be ironed out without much difficulty. This need the Engineering Standards Association is to supply. Again, it is entirely too easy to standardize a process or a product in such a way as to bar all further progress. There is less likelihood of this being done if it is possible to hear from all interested organizations. Manufacturers and commercial organizations have sometimes objected to certain standards because they seemed to be impractical and to be prepared by persons not entirely acquainted with processes of manufacture. It will be their own fault if such a thing happens in the future, as ample provision is made for representation of all parties concerned. It might be mentioned in closing that there is no intention to have the new organization supplant the American Society for Testing Materials, but rather to co-operate with it and to extend its methods and work. In this connection, we would call attention to the fact that on page 316 in the seventh line from the bottom of the first column, the word 'revise' should read 'receive'. This correction was received from the Association after that part of the magazine had gone to press.

Vocational Education and the Apprentice Question

Last month we published a discussion of the apprentice question by Mr. John Hedley, a well-known foundryman. Mr. Hedley's statement regarding the difficulty of maintaining the supply of really skilled workers in the foundry applies with equal force to the other metal trades. The number of boys that enter upon an apprenticeship is small; many of those that do so tire of it before long, and even if they continue in the trade, never really learn it. The boys that complete their apprenticeship are far too few to replace the natural losses, much less provide for the increase that is necessary if the metal industries of this locality are to grow in pace with the times. In the machine-shops, for instance, there are many men calling themselves machinists that are really machine operators. Conditions have been aggravated by the labor shortage of last year, as a result of which many

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men have assumed, because they have learned to do a few repetitive operations well and rapidly that they were skilled craftsmen and are unwilling to take the time really to learn the trade.

On top of all this comes the fact that immigration has ceased, probably for an indefinite period from European countries, which, with all their faults, are thorough in teaching a trade. If the foreign craftsman no longer comes here, and the American boy will not exert himself to learn a trade in the former thorough way, what are we going to do? The best answer to this question seems to be found in the Smith-Hughes Act for Vocational Education, which is discussed elsewhere in this issue. The most important feature of this measure is not that it provides for the expenditure each year of a certain amount of Federal and State money for local schools, important as that undoubtedly is, but rather the fact that here, for the first time, is an opportunity for establishing really practical vocational education on a sound basis. Our schools have been supposed to prepare students to make a living. Actually they have given fair opportunities for clerical work and some other lines, but have done nothing for the trades. As Mr. Hedley's article showed, many, even of the polytechnic schools have, doubtless with the best intentions, educated their pupils away from rather than for the trades. In fact, many of the graduates simply refuse to enter the trades at all.

Courses under the Smith-Hughes Act, on the contrary, are arranged to train boys for the trades. The applied work is not devoted to making bric-a-brac but to real things of practical value. How to do certain things and why he does them that way are taught the boy in either the school shop or a commercial one and in the class room. The pupil is even encouraged during the last year or two of his high-school course to take his applied work in a commercial shop as part of a regular apprenticeship.

Another aspect of the Smith-Hughes Act deserves special mention. Hitherto, there has been a general impression that organized labor was hostile to vocational education as such. It is probable that this was never the attitude of the really far-sighted labor leaders or of the more enlightened union men in general. However, the opinion was so general that there must have been some foundation for it. The present measure, however, was prepared in the offices of the American Federation of Labor and had the support of labor leaders during its passage through Congress. A prominent union leader, Mr. Arthur E. Holder, who, by the way, is a machinist by trade, is a member of the Federal Board. Anything that raises the standard of ability and performance in a certain trade ultimately raises the standing of that trade in the community at large. The sensible union men recognize this and favor vocational education as now provided. The Bolshevik type of union man naturally opposes it, but none of us are particularly anxious to please him.

Co-operation between the employer, the unions, and the school authorities is necessary or vocational education will be a sorry failure or, at least, will fall far short of what it might be. It is up to the men in the metal industries of this district to encourage the school authorities to establish vocational courses, to encourage boys in their employ or otherwise to take these courses, and to act as a sort of advisory committee to the school authorities, the teachers, and the boys themselves. It hardly contributes to local pride to learn that nearly every high school in Los Angeles as well as several in smaller towns have established courses under the Smith-Hughes Act, while in the entire San Francisco Bay district only two schools have taken advantage of the Act, and these two are in Oakland. One thing must be remembered, the Federal and State Boards cannot and will not take any steps toward the establishment of courses except at the request and with the co-operation of the local authorities.

A particularly important field for advice from the practical man operating a commercial shop is the matter of part-time co-operative courses, where the applied work is taken in a commercial shop as part of a regular apprenticeship. The present policy of the State Board of Education is to encourage courses of this kind with a length of one or two years, either for the last year or two of a four-year course or expressly for the boy that at least thinks he is unable to take more than one or two years of training altogether. However, there is nothing in the original Act to prevent a regular four-year apprenticeship with a certain part of the time devoted to school-study, and it is quite likely that the State Board would consent to such courses being tried provided the proper representations were made. Under such a system, rightly administered, a boy would learn far more than he could under the present style of apprenticeship, and probably earn just as much. This is only one of the many problems where the advice and co-operation of employers is needed. There is also the question whether, in part-time co-operative courses, the shop work shall be taken on alternate half-days, alternate weeks, or some other alternate period. Again, there is the establishment of part-time courses taking a few hours each week for older employees and for boys who are unable to take a regular vocational course. Perhaps the most important question of all is that of employment after graduation from a vocational course. It is of no use to teach a boy a trade if he is unable to follow it after he learns it. That is a matter for co-operation between the employers, the labor unions, the school authorities, and the general public.

The two years since the passage of the Smith-Hughes Act have been years of war and stress of all kinds, and the energies and attention of the men in the metal industries have been occupied with matters that for the time at least were more important than industrial training. The time is now ripe for a careful study of the question of vocational education and for cordial co-operation with the Federal and State authorities, who have charge of the new plans.

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Important Excerpts From National Industrial Reports

By FRED C. METCALF

A joint resolution has been introduced in Congress (H. J. Res. 121) (S. J. Res. 57) which authorizes the President to appoint 20 men to consider such problems as the permanent relation between capital and labor, industrial management, participation in profits, wage adjustments, settlement of industrial disputes, and the improvement of working conditions and hours. It is proposed that the conference make recommendations to employers and employees, which shall serve as a guide in their relations with each other.

The names of the prospective conferees are mentioned in the resolution. Labor is to be represented by Mr. Frank P. Walsh, former chairman of the War Labor Board and by the presidents of eight national labor organizations. Among these may be mentioned Messrs. Samuel Gompers, Andrew Furuseth, W H. Johnston, A. B. Garretson, and C. H. Moyer. Capital is represented by such men as Messrs. Charles E. Hughes, John D. Rockefeller, J. P. Morgan, J. Ogden Armour, E. H. Gary, W. K. Vanderbilt, and Daniel Guggenheim. The Government is represented by Mr. William B. Wilson, Secretary of Labor, and Mr. Franklin K. Lane, Secretary of the Interior. It will be noticed that the employer and the manufacturer have little direct representation. The thousands of manufacturers who are not associated with the few big corporations have no representative in this conference. The representatives of capital are distinctively representative of the financial end of the corporations. Union labor is most completely represented, and the Secretary of Labor, who is a union man first, is one of the representatives of the Government. Only union labor, which is 8% of the labor of the country, is represented by the men mentioned in the resolution.

Emphatic protest should be made to Congress at the exclusion of the active manufacturing interests of the country from participation in the conference.

In a case against the United Mine Workers of America, charged with violation of the Sherman Anti-Trust Law, the verdict of $200,000 automatically trebled, is affirmed by the United States Circuit Court of Appeals. The decision establishes the responsibility of a labor union if it or its members in pursuance of union aims enters into a conspiracy in restraint of inter-state commerce. The Court holds that the national body of the United Mine Workers is responsible for acts of its branches, and that where a union has power to discipline its members for illegal acts, and, having knowledge of such acts, fails to exercise that power, it is responsible for whatever damage results.

In response to a letter from the International President of the Amalgamated Association of Iron, Steel and Tin Workers, Mr. E. H. Gary, of the U. S. Steel Corporation, which employs more than a quarter of a million workers, announces that the company intends to continue operations under the open-shop plan. He writes, under date of May 20, 1919, "I have read with interest your letter of May 15. I agree that it is the patriotic duty of all good citizens to use their efforts in stemming a tide of unrest in the industrial world whenever and wherever it exists. As you know, we do not confer, negotiate with, or combat labor unions as such. We stand for the open-shop which permits a man to engage in the different lines of employment whether he belongs to a labor union or not. We think this attitude secures the best results to the employees generally and to the employer. In our own way, and in accordance with our best judgment, we are rendering efficient service in the direction indicated by you."

According to the official summary of the Treaty of Peace, the members of the League of Nations agree to establish a permanent organization to promote international adjustment of labor conditions to consist of an annual international conference and an international labor office. The conference will be a deliberative legislative body with four representatives from each member nation. Two of these will be from the government of the nation and one each from the employers and the employees. The recommendations of a two-thirds vote of this body must be submitted to the law-making authority in every nation participating. The labor office is to collect and distribute information on labor throughout the world. The first conference will be held in Washington next October. The principal topics include the 48-hour week, prevention of unemployment, the use of white phosphorus in the manufacture of matches, and the employment of women and children at night or in unhealthy work.

Nine principles of labor conditions were recognized. They include the guiding principle that labor should not be regarded merely as a commodity, the right of association of employers and employees, an adequate wage to maintain a reasonable standard of living, the 8-hour day or 48-hour week, a weekly rest of at least 24 hours, abolition of child labor, equal pay for equal work between men and women, equitable treatment of all workers including foreigners lawfully residing in a country, and a system of inspection of working conditions in which women should take part.

After an attempt to formulate an American standard of living the United States Commissioner of Labor Statistics decided that there is no such thing. Although from a statistician's standpoint it is probably true that though no unyielding minimum can be discovered, there is, nevertheless, a standard of living in the United States that is definitely superior, class for class, to that of other countries. It is a standard easily lowered by hasty legislation, uneconomic reform, and a false public attitude toward business activities. It should, in particular, be clearly understood that the price to be paid for the American standard of living is continuous and unrestricted production and uninterrupted operation of all forms of public service.

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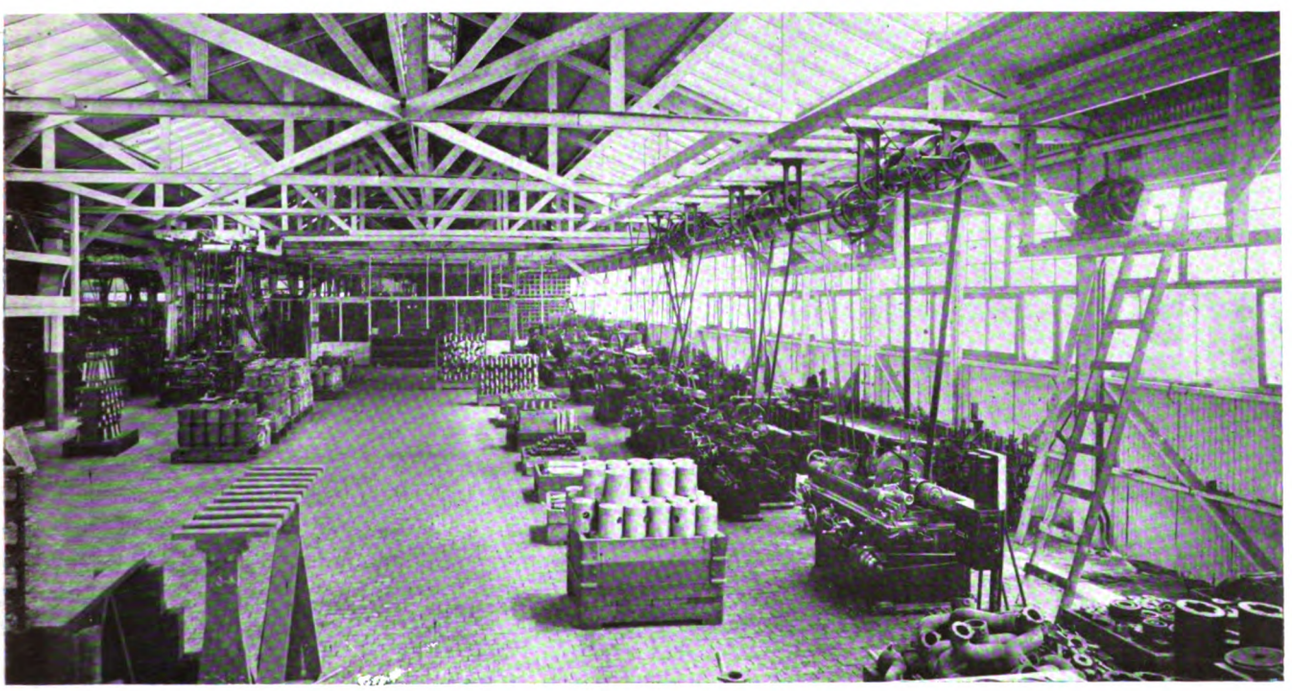
THE FINISHED PRODUCT.—PLOWING WITH A BEST 60-HP. TRACTOR

Grinding at the C. L. Best Plant

THE increasing use of alloy-steels in the manufacture of gas engines has caused the installation of a great deal of grinding equipment in the plants of engine and tractor manufacturers. The C. L. Best Gas Tractor Co. has recently made some additions to its plant at San Leandro, and its grinding facilities are now as complete as any on the Coast. Practically all the shafting used in the transmission system and other parts of the company's tractors is of alloy steels. These shafts are heat-treated and it is impractical to finish them by any other method than grinding. All shafts are rough-turned to within 0.020 or 0.025 in. of the size, and then ground.

The grinding department is situated in a well-lighted bay at the west end of the factory. Only manufacturing grinding is done in this department. The other grinding equipment, such as universal grinders for tools, is placed in other departments. The cylindrical grinders are



GENERAL VIEW OF GRINDING DEPARTMENT. CYLINDRICAL GRINDERS ON RIGHT.

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CYLINDRICAL GRINDERS. PLATFORM-TRUCK AT LEFT

placed in line on one side of the bay and the internal grinders are on the other, with a large aisle between them. All the machines are belted to individual motors. The floors of the factory are of redwood blocks and the the material is handled on platforms by Cowan lift-trucks. Special racks are provided for crankshafts and sectional bins for small material. By this method the machines are served with a minimum amount of handling and the floors are kept clear of material.

The following cylindrical grinders have been installed: one 10 by 36-in. Norton, one 10 by 52-in. Norton, one 16 by 32-in. Brown & Sharpe, one 14 by 24-in. Modern, one 20 by 60-in. Landis crank-shaft grinder, and one 26 by 96-in. Landis crank-shaft grinder. This last machine is shown in the illustration at work on a 75-hp. crank. With these crank-shaft grinders no off-set centres are needed, as there are clamping holders at both ends to hold the cranks. These are operated quickly and save considerable time. There are disadvantages in the use of off-set centres, the principal one being the time taken to set them correctly on the work. Furthermore, the accuracy of the grinding depends upon the centres being absolutely true. They must, therefore, be replaced when worn out of true, and the cost of manufacture and replacement is large.

In the Landis machine mentioned above, the cranks are driven from both ends, the head and the foot-stock being geared together. The different throws are set by an eccentric adjustment of the work carrying the heads on the face-plates. For multiple-throw shafts the pins are ground in their exact relative positions with each other, and for this they are located by indexing fixtures on the heads, having twelve 30° divisions, which gives all of the regular throw-angles.

On the opposite side of the bay are three Heald internal grinders. Two of these, which are No. 60 machines, work entirely on cylinders. This type of machine was designed especially for such work and it contains many valuable features. There are several advantages in finishing the bore of a cylinder by grinding as compared with boring or reaming. In the latter method the thin walls of light engine-cylinders are apt to spring away from the cutting-tool when there is a hard spot in the iron. This is likely to leave a hard spot in the finished cylinder, which will cause friction with the piston and rings, as well as a compression leak on each

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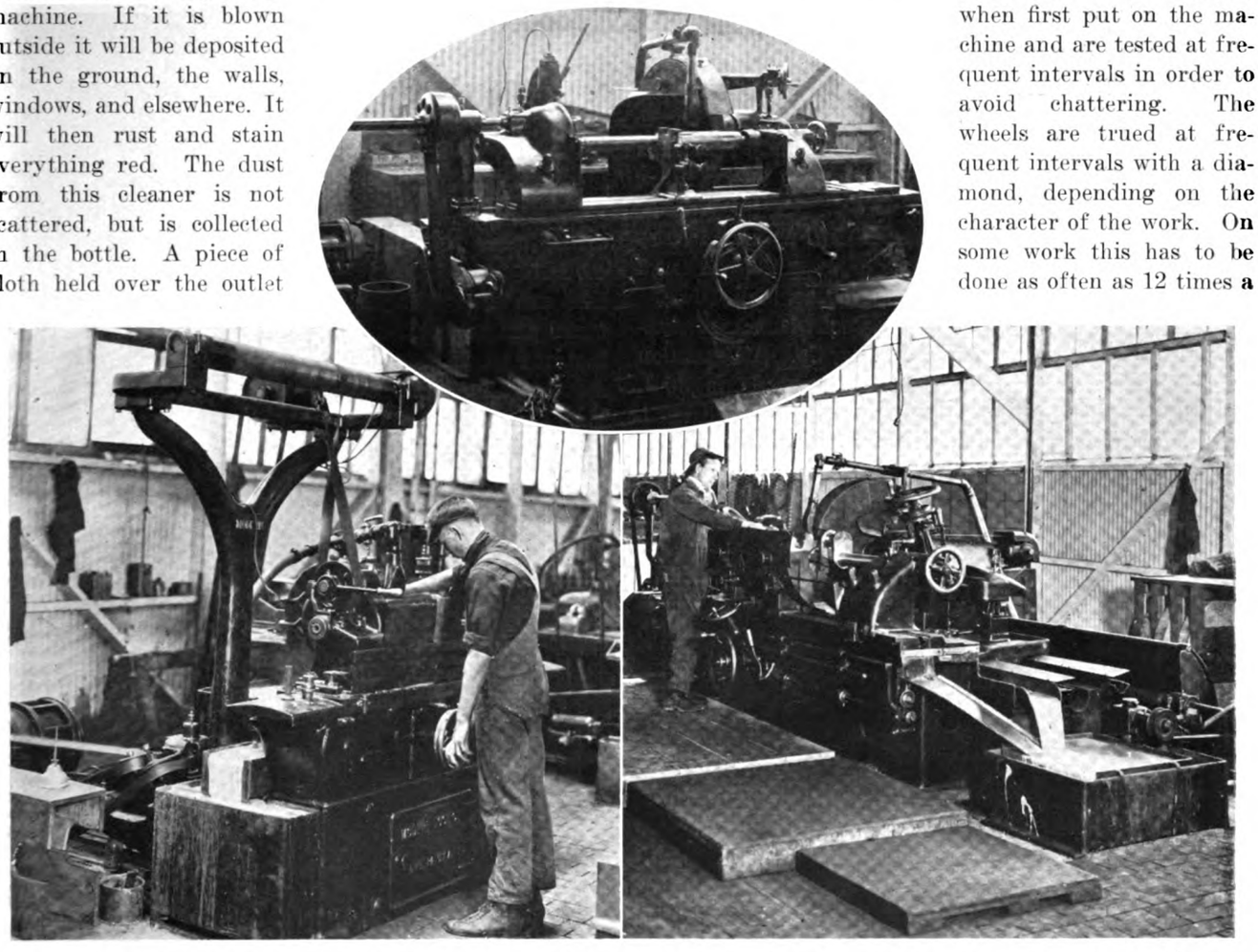
side. Wherever there is a soft spot in the iron, the boring-tool is likely to sink too deep, causing a hole that also makes a compression leak. The grinding-wheel, however, cuts the metal in a perfectly true circle without putting great pressure on the cylinder walls, and regardless of hard or soft spots or of ports. The greatest advantage, however, is the much finer finish that can be given the surface. The machine has an efficient fixture for holding the cylinder in place. The cylinders are clamped against an angle-plate mounted on the cross-slide table. Thus, the holes are set up square with the flange at the end of the cylinder. A cylinder of $7\frac{3}{4}$-in. bore is ground in 45 minutes. A cylinder of $4\frac{5}{8}$-in. bore is ground in 20 minutes. The exhaust from the internal cylinder-grinding machines is taken through a separator similar to the cleaner used on the tractor to separate the dust from the air before it enters the carbureter. This is a simple centrifugal separator and has no internal moving parts. Centrifugal force generated by the rapidly swirling air causes the emery and iron dust to be deposited against the cleaner. It then falls into the glass jar that is shown in the illustration directly under the cleaner. When such a separator is not provided the fine iron from the cylinder-grinder is scattered everywhere in the vicinity of the machine. If it is blown outside it will be deposited on the ground, the walls, windows, and elsewhere. It will then rust and stain everything red. The dust from this cleaner is not scattered, but is collected in the bottle. A piece of cloth held over the outlet will show no trace of grit, the separation being complete.

All hardened gears are ground after being chucked by the roller method as shown in the photograph of the Heald No. 75 grinder. In this method three rollers are centred on the pitch-line of the gear, which insures that the gear will be true with the pitch-line of the teeth. The bore and face are both ground in one setting.

A number of parts are ground by using the wide-face type of grinding-wheel. Lengths up to six inches are ground and held to close limit. Much better time can be made by this method. Sixty $4\frac{5}{8}$-in. pistons are ground in eight hours within 0.001-inch limit. The bevel gears, one of which is shown being ground on the Brown & Sharpe grinder, are finished in eight minutes each. The valve-tappets are ground in the heavy-duty Modern machine in five minutes each.

Crank-shafts are ground by feeding the wheels straight in on the bearing up to five inches long. On longer bearings the table-traverse is used. The corners of the wheels are rounded with a radius device for crank-shaft work. This radial fixture is suited for turning the face of the wheel and forming corners to an exact radius for grinding fillets up to $\frac{1}{2}$ in. radius. It can also be used for truing the sides of the wheels for grinding shoulders.

The wheels are balanced when first put on the machine and are tested at frequent intervals in order to avoid chattering. The wheels are trued at frequent intervals with a diamond, depending on the character of the work. On some work this has to be done as often as 12 times a



ABOVE—GRINDING TRANSMISSION-SHAFT ON LANDIS GRINDER. AT LEFT—GRINDING VALVE-TAPPETS ON MODERN MACHINE. AT RIGHT—GRINDING A 75-HP. CRANK-SHAFT ON LANDIS MACHINE.

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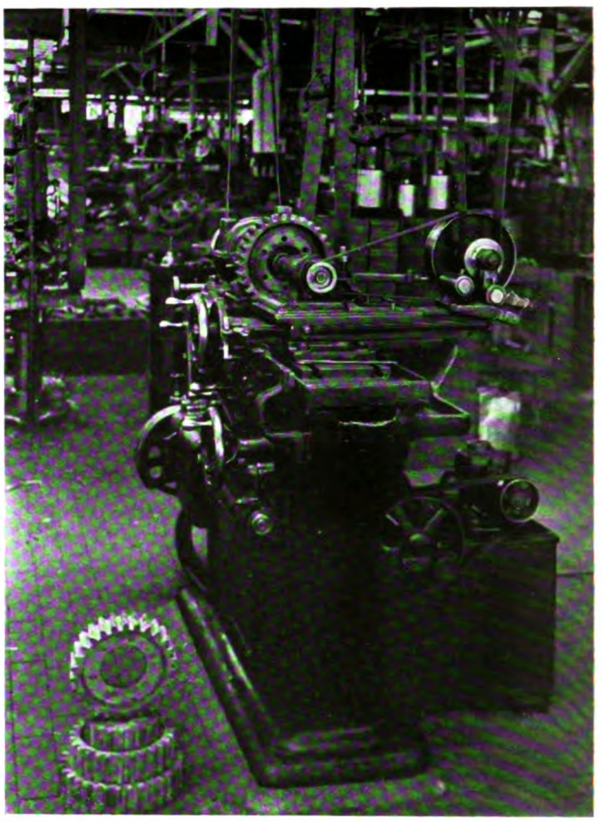
No. 60 HEALD GRINDERS WORKING ON CYLINDERS



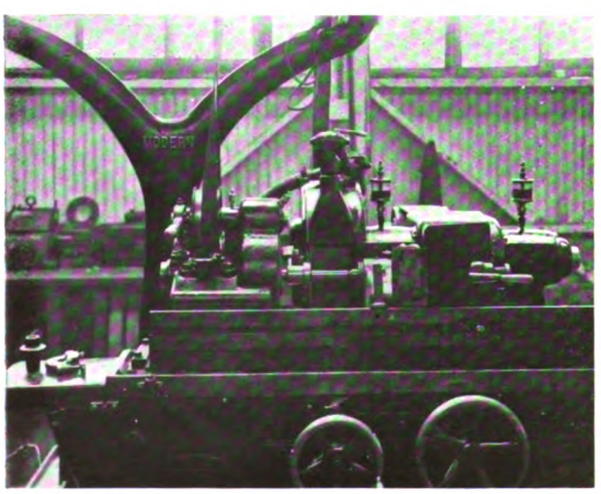
No. 75 HEALD GRINDER WORKING ON GEARS

day. The wheel-dresser is not used, as in most instances the work is turned close to the size in the lathe and is finished on the grinder.

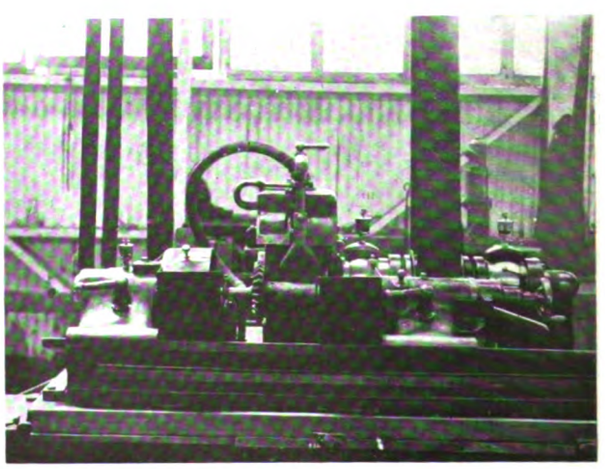
A soluble oil mixed with water is used as a lubricant. This mixture does not rust the machines or the work and keeps the latter at a uniform temperature.

The grinding wheels used at the Best plant are manufactured by the Norton Manufacturing Co. A Crystalon wheel is used on the cylinders. The grade is 30-J. For alloy-steel grinding the alundum wheels are used. This material is aluminum oxide and is practically an artificial corundum made in the electric furnace. A medium wheel is used on the forgings, usually No. 24.

To find the most efficient wheel for each job is a matter of trial. No two jobs are the same and sometimes several grades of wheel have to be tried before the correct one is found. Although small differences in material can be handled by changing the work speed, the fastest and most economical work is obtained when the correct-grade wheel is used. For steel the best practice is to use a fairly soft, coarse-grained wheel and to complete the job on the same wheel.



MODERN GRINDER WORKING ON VALVE TAPPETS



GRINDING BEVEL GEAR ON BROWN & SHARPE MACHINE

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Oxygen in Cast-Iron and Its Application*

By WILFORD L. STORK

CERTAIN influences of oxygen on iron have been known for many years and it has always been considered one of the worst enemies of the iron and steel founders. Nobody had a good word for it, hence little was done to make use of this oxygen. In all the fields of foundry practice, the object was to melt without oxidation of the metal.

In considering the influence of oxygen on cast-iron, we must not be confused by our experience with iron oxidized by poor melting-conditions, caused by a high bed, heavy charges, low coke-ratio, excessive melting-rate, high blast, or poor charging. It is admitted that oxygen absorbed by iron melted under these conditions has a deleterious effect on the properties of the iron. The oxidized condition cannot be counteracted or removed by any of the known de-oxidizers; it can be remedied only by proper melting conditions. Such iron is really burned, whereas the iron considered in this paper was melted under normal conditions with moderate blast, correct bed-height, light charges of iron, and low coke-consumption.

In 1914, the late J. E. Johnson, Jr., startled the metallurgists of the world when he published his conclusions regarding the good effect of oxygen on cast-iron. His work is so convincing and so logical, in spite of the common and well-established notions on the subject, that nobody has been able to refute a single argument. It has revolutionized the metallurgy of cast-iron and it seems apparent that all future work must include an oxygen determination just as we include silicon, sulphur, phosphorus, manganese, and carbon in our every-day analyses. A summary of the part of this work that applies directly to the contents of this paper is as follows:

1. Iron containing oxygen solidifies at a higher temperature than iron of the same composition containing no oxygen.

2. Oxygen increases the strength of cast-iron.

3. Iron containing oxygen, if cast in sand, contains somewhat more combined carbon than a similar iron not containing oxygen.

4. Iron containing oxygen, if cast against a chilling surface, will show a white chill at a higher silicon than a similar iron not containing oxygen, and will show a greater chill for the same silicon as the latter element decreases.

5. When manganese is added to a metal high in oxygen, some of the latter is removed and the chilling power and strength are thereby reduced.

6. Steel, when added to cupola mixtures, is oxidized and it is this oxygen content that gives such mixtures superior physical properties.

The purpose of this paper is to give further evidence in support of the above theories and to show their application to cupola mixtures.

Iron poured hot will always have more combined carbon in the test-bar or casting than the same iron poured colder as a result of holding it in the ladle. This is true for both white cast-iron and gray iron. It is possible to get a white, mottled, or gray fracture of white cast-iron, simply by pouring at different temperatures, in accordance with the well-known law that the more slowly iron is cooled the more graphitic and the less combined carbon will the iron have. But when iron is held in a boiling ladle (first catch in a re-lined ladle), the heat of the molten iron drives off the water of combination from the clay, which, when converted into steam, passes through the iron causing boiling. The steam is decomposed into hydrogen and oxygen; the oxygen attaches itself to the iron molecules and the hydrogen passes off to the atmosphere. The result is the iron becomes less fluid, not merely because of its lowering temperature, and the combined carbon is increased.

The iron in the state of boiling gives the manganese and sulphur the opportunity and time to get together to form manganese sulphide, which rises to the surface as slag. The oxygen content of the iron increased its combined carbon and raised its melting-point, causing it to become sluggish.

In melting much iron of different analyses, day by day, the adjustment for the manganese loss varied in the different mixtures, but was quite constant in each particular grade. This had to be considered in order to keep the mixtures up to specifications. The mixtures carrying steel lost a greater proportion of manganese than those without steel. For instance, in a mixture of 50% pig-iron and 50% re-melt, the manganese content was:

	%		%
Charged	0.80	Loss	0.11
Spout	0.69	Proportional loss	13.70

whereas in a cylinder mixture made up of 15% steel, 40 to 50% re-melt, and 45 to 35% pig-iron, the manganese content was:

	%		%
Charged	0.90	Loss	0.19
Spout	0.71	Proportional loss	21.10

With special mixtures, as will be shown later, the loss of manganese is considerably higher. These are averages of months of operation. The steel in the cupola

*Abstract of paper to be presented at the Chicago meeting of the American Institute of Mining and Metallurgical Engineers, September 1919.

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oxidizes, adding oxygen to the mixture, which in turn is removed by the manganese. The proportional manganese lost increases with the increased steel content of the mixture, for the higher the steel content the greater is the oxidation and the more oxygen to be removed. In the cylinder mixture carrying 15% steel, it was necessary to charge the iron at 0.90% or above in manganese, in order to give the iron proper fluidity to run such complicated castings as automobile cylinders. The oxygen content caused by the steel raised the melting-point. Of two irons at the same temperature, the one with the lower freezing-point will have more superheat and more life than the one with the higher freezing-point. The oxygen added to the iron through the steel raises its melting-point, causing it to become sluggish; and in order to give the iron the required life, it must be de-oxidized with manganese. This fact was so readily observed that fluidity was controlled entirely by manganese.

Iron with 20% steel chills more easily, has a greater shrinkage, is harder, and will throw a deeper chill than iron with 10% steel, unless extra manganese is added to remove this additional oxygen.

Cast-iron was specified by the Ordnance Department for its 155-mm. gas-shells. In order to meet the specifications, I applied the aforesaid theories and facts to my mixtures with success. The iron was deliberately impregnated with oxygen by using a large proportion of steel. Deoxidation was prevented by keeping the manganese below 0.45 and above 0.33%. The Government demanded a tensile strength of over 32,000 lb. per square inch. The impact-test required that a 1¼-in. square test-bar supported on knife-edges, 6 in. centre to centre, should not break before the drop of the 25-lb. hammer, carrying a knife-edge, reached 18 in., starting at 12 in., and increasing by ½-in. increments. Mixtures were made of 35 to 40% steel, 35% re-melt, and 30 to 25% pig-iron. A typical charge was 150 lb. Star pig-iron, 450 lb. Toledo pig-iron, 700 lb. re-melt, 700 lb. steel, and 2 lb. ferro-manganese.

The tensile strength ran from 32,000 to 37,000 lb. per square inch; bars which broke below 32,000 lb. proved to be defective castings.

The results bear out the various contentions in reference to the oxidation of steel in cupola mixtures and the effect of oxygen on cast-iron. For a like silicon content, the combined carbon and chill are decreased as the manganese is increased, because the manganese acts as a de-oxidizer. These results are not for the same ladles of iron, but are from different days and are the general trend of conditions and results.

The manganese loss was high in these mixtures, as shown by the following, with which the losses under conditions less favorable to oxidation are repeated.

	Manganese			
Steel	Charged	Spout	Loss	Proportional Loss
%	%	%	%	%
0	0.80	0.69	0.11	13.7
15	0.90	0.71	0.19	12.1
35	0.64	0.38	0.26	40.0

There was an abnormally large amount of slag in these runs and it became necessary to reduce the limestone from 80 to 20 lb. per ton of iron. Later, it was found possible to discontinue the use of limestone with these heavy steel charges. Without any limestone the slag was sufficiently fluid and no trouble was experienced with a viscous slag.

Furthermore, with 0 to 10% steel, the slag-hole was opened only after 2 to 2½ hours of operation, whereas with these special steel charges it was advisable and almost necessary to slag the cupola 30 to 40 minutes after the first tap.

The contents of this paper proves the validity of the late J. E. Johnson, Jr.'s theory of oxygen in cast-iron and shows how it has been applied to cupola mixtures to obtain iron of definite physical properties and also how it explains many conditions met in foundry practice. Even the chill can be controlled by varying the manganese in irons containing oxygen and the influence of oxygen on the fluidity can be controlled by the manganese. While this method is not as good as the patented process of oxygenating cast-iron, nevertheless we can make use of the method indirectly and can apply the theory involved to our daily foundry problems. It also shows the absurdity at times of considering the influence of silicon on the chill, strength, or fluidity of cast-iron when the oxygen content is neglected, as we can produce almost any desired chill for any silicon content simply by varying the oxygen.

The Wail of Goody Boy

My parents forbade me to smoke
I don't.
Nor listen to a naughty joke
I don't.
They made it clear I must not wink
At pretty girls, nor even think
About intoxicating drink
I don't.
To dance or flirt is very wrong.
Wild youths chase women, wine and song
I don't.
I kiss no girls, not even one,
I do not know how it is done,
You wouldn't think I have much fun
I don't.

Author Unknown
(For obvious reasons).

A SWEDE came down from the woods, and, entering a saloon, asked for a drink of good old squirrel whiskey.

The bartender said: "We have no squirrel whiskey, but we have some good Old Crow."

"Oh, Yudas Priest!" said the Swede, "I don't want to fly, I yust want to hop around a little."

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Vocational Education Under the Smith-Hughes Act

WHILE the Federal government has from time to time taken measures to encourage vocational education, and has done so specifically in the case of the so-called 'land-grant' colleges, the first step to provide Federal assistance for what it is to be hoped will ultimately develop into practically universal vocational education was the passage of the Smith-Hughes Act in February 1917. This Act is printed in full in Bulletin No. 1 of the Federal Board for Vocational Education. In brief, the provisions of the Act as far as industrial education is concerned are as follows, disregarding as far as possible the regulations regarding agricultural and home economics education:

Appropriations are made for the purpose of co-operating with the States in paying the salaries of teachers of trade, home economics, and industrial subjects amounting for the fiscal year ended June 30, 1918, to $500,000, and increasing each year until the maximum of $3,000,000 is reached in the fiscal year ending June 30, 1926. This annual appropriation of $3,000,000 is to be continued indefinitely. The allotment to the several States is made in accordance with the urban population of each State. Not more than 20% of the appropriation is available for salaries of teachers of home economics subjects, leaving at least 80% for teachers of trade and industrial subjects.

The Smith-Hughes Act provides for Federal assistance for practical instruction in industrial training.

For the training of teachers, supervisors, and directors of agricultural subjects and teachers of trade, home economics, and industrial subjects, the sum of $500,000 was appropriated for the fiscal year ended June 30, 1918, the appropriation increasing each year until the maximum of $1,000,000 is reached in the fiscal year ending June 30, 1921, which yearly appropriation is continued indefinitely. The allotment to the several States is made in accordance with the total population of each State.

Funds are also provided for the training of teachers in industrial subjects.

In order to secure the benefits of these appropriations, each State must appoint a State Board for Vocational Education, to co-operate with the Federal Board. (This has been done in every State.) The State Board prepares plans for vocational education and submits them to the Federal Board for approval. The Federal appropriation is devoted exclusively to the payment of salaries of teachers having the minimum qualifications determined by the State Board and approved by the Federal Board. The cost of instruction supplementary to the instruction in trade and industrial subjects necessary to build a well rounded course of training is borne by the State and the local communities. For each dollar of Federal money expended for salaries as already provided, another dollar of State or local funds must be expended for such salaries. Similar provisions for a '50-50' division of expenses are made regarding the training of teachers. All expense for necessary plant and equipment is to be borne by the State or the local community.

Co-operation of State and local authorities is required before Federal funds can be obtained. The industrial courses established must conform to certain standards.

Further, in order to receive these appropriations, the State Board must provide that the schools and classes shall be under public control; that the controlling purpose shall be to fit for useful employment; that the education shall be of less than college grade; and shall be designed to meet the needs of persons over 14 that are preparing for, or have entered on a trade; that at least one-half of the instruction shall be given to practical work on a productive basis, such instruction to extend over not less than nine months per year and not less than 30 hours per week.

It is further provided that at least one-third of the sum available in each State shall be used for part-time schools or classes for workers over 14, who have entered upon employment. In the case of part-time schools, this money is available for salaries of teachers in subjects given to enlarge the civic or vocational intelligence of workers over 14 and under 18. Part-time classes shall provide for at least 144 hours of instruction per year. In evening schools, the minimum age shall be 16, and instruction shall be confined to that which is supplemental to the daily employment.

Provision is also made in the bill for the drawing of funds, making of reports, etc.

The Federal Board for Vocational Education is composed of four *ex officio* members, David F. Houston, Secretary of Agriculture; William C. Redfield, Secretary of Commerce; William B. Wilson, Secretary of Labor; and P. P. Claxton, Commissioner of Education; and three private citizens appointed by the President, James P. Munroe, representing manufacture and commerce; Charles A. Greathouse, representing agriculture; and Arthur E. Holder, representing labor. C. A. Prosser is director of the executive staff, and Lewis H. Carris is assistant director for industrial education. The country

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has been divided into five districts, with headquarters at New York, Atlanta, Indianapolis, Kansas City, and San Francisco, respectively. Offices for the San Francisco district are in the Monadnock building. This district comprises California, Nevada, Washington, Oregon, Idaho, Utah, and Arizona.

Besides the administration of the Smith-Hughes Act, the Federal Board for Vocational Education has charge of the re-education of disabled service-men. During the War, it also had general oversight of industrial training in the various plants engaged in war work.

In California, Edwin R. Snyder is commissioner of vocational education, and John C. Beswick has recently been appointed in charge of the trade and industrial work.

The following amounts are available in California from Federal sources for salaries of teachers in trade, home economics, and industrial subjects, an equal amount being available from State sources: For the year ending June 30, 1920, $34,751.92; ending June 30, 1921, $43,439.90; ending June 30, 1922, $52,127.88; ending June 30, 1923, $60,815.86; ending June 30, 1924, $69,503.84; ending June 30, 1925, $86,879.80; ending June 30, 1926, and thereafter, $104,255.76. The figures for the years ending June 30, 1922, and thereafter are necessarily approximate, as they are based on 1910 census, while the final apportionment will be made on the basis of the 1920 census. Of these sums, at least 80% must be used for trade and industrial training, and at least 33⅓% of the total amount appropriated in each year must be used for part-time instruction, including whatever amount may be used for part-time instruction in home economics. For the training of teachers in all vocational subjects, agriculture, home economics, and trade and industry, the following amounts are available in California from Federal sources, and an equal sum from State sources: For the year ending June 30, 1920, $23,349.69; ending June 30, 1921, and thereafter, $25,944.41. The figures for the years ending June 30, 1922, and thereafter are subject to revision with the 1920 census. Of these amounts not less than 20% nor more than 60% will be available for training teachers in trade and industrial subjects.

At least $55,000 of Federal and State funds will be available for trade and industrial training in California during the coming school year.

Bulletin No. 23-A of the California State Board of Education 'Documents Relating to Vocational Education' contains statements regarding the policy of the Board and other information from which a large part of the following is taken:

The purpose of the Federal and State Acts is to promote vocational education, not to provide funds for general education, or vocational courses that are already well financed by the State and by local communities. The most important problem at present is the development of part-time and full-time courses in the various trades and industries. Naturally the larger industrial centres offer the best opportunities for the solution of the problem. Later, this work can be extended to the smaller communities. For the present the Board will not apply any of the special Federal and State funds to the promotion of vocational classes in which more than half of the class period is after 6 p.m. For salaries in courses as already outlined there will be available for each 'teacher-unit of instruction' $600 from Federal and State funds. A 'teacher-unit of instruction' is defined as six 60-minute periods of instruction each day for the school year of not less than 36 weeks. This is for teachers receiving not less than $1200 per year. It is further provided that if the funds available are insufficient to provide $600 for each 'teacher-unit of instruction' in approved courses, the amount shall be divided pro rata. School authorities desiring to take advantage of the Smith-Hughes Act must submit detailed information as to plans to the State Board of Education.

The California State Board of Education is making special efforts to have trade and industrial courses established in the larger cities.

Full-time courses in trades and industries will conform to the following general plans: Not less than three hours per day of each pupil's time must be devoted to applied industrial or trade work, and not less than three hours per day to supplemental and other academic work, provided that if an equivalent amount of time be given to each, the academic and the practical work may be planned to alternate daily, weekly, or bi-weekly, and provided that at least half the time shall be devoted to applied work. As far as possible the applied work must be conducted in a manner similar to that followed in the best industrial shops. Pupils pursuing the first year of the course must spend at least half of the time devoted to applied work on projects that have a marketable value, and pupils pursuing other years at least two-thirds of such time. Where a course exceeds two years in length, or where it is planned to cover only the last two years of a four-year high-school course, it is recommended that a part of the experience in applied work shall be secured under apprenticeship as described below under part-time co-operative courses. Classes shall not contain more than 20 pupils. The local school authorities must provide plant, equipment, and supplies as may be recommended by the State Board of Education, and must spend for salaries, overhead, and other current expenses not less than $1500 per year for each class organization. Any person over 14, who may be able to profit by the work of the course, shall be admitted thereto, without regard to scholarship or grade of school previously attended.

The pupil's time is divided between applied work in the shops and supplemental academic work.

Part-time co-operative courses may be one or two years in length. Not less than three hours per day shall be devoted to supplemental and other academic work, and not less than three hours per day to employment as an apprentice in the trade or industry for which the pupil

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is preparing, with the same provisions for alternate daily, weekly, or bi-weekly instruction and shop-work as for full-time courses. The same requirements for admission are in force, as for full-time courses, subject only to the State child-labor laws. Other important regulations are similar to those for full-time courses.

Part-time courses, not co-operative, are subject to the general provisions of the Federal Act, as already noted, and the further statement of policy by the State Board of withholding Federal and State aid from evening schools. Instruction may be given only in such subjects as will increase the skill or knowledge of the worker in his daily employment, or will lead to advancement in that employment. Any employed person over 16, who may be able to profit by such a course, may be admitted to classes maintained outside of working-hours, and any person over 14 to classes maintained within working-hours. Local authorities must provide plant, etc., as for full-time schools, and $100 per pupil per year must be spent by them for salaries and other running expenses.

Part-time general continuation classes in civic and vocational subjects differ from the part-time classes already noted in being intended for employed persons of high-school age, who are not engaged in skilled occupations. As such, they are not of special interest to the metal industries, and will not be discussed further in this article.

Success of the vocational education work contemplated under the Smith-Hughes Act is dependent as much upon the selection and training of the proper teachers as upon anything else, particularly during these first few years after the passage of the Act. Certification of teachers in vocational subjects, like certification of all other teachers, is under the control of the State Board of Education. For giving instruction in applied work in industrial subjects, two general types of teachers will be accepted. The first of these types is represented by the widely experienced craftsman, and is defined as including persons 25 or over, who have had a minimum of three years experience as journeymen workers or its equivalent in the vocations they expect to teach and, in addition thereto, at least an elementary school education. In addition, they should have satisfactorily completed the work of the classes for training of vocational teachers established in accordance with the Federal and State Acts. The second or technically trained type includes persons who have had at least two years vocational experience in their special fields, and who have completed technical courses at a college or university. The so-called 'supplemental' subjects shall be taught by teachers of applied subjects, or by other qualified high-school teachers. Classes for training teachers of applied subjects have been established at the University of California and at some of the State Normal Schools.

Teachers must be either skilled craftsmen in the trades they are to teach or else technically educated men with practical experience in these trades.

During the year ended June 30, 1918, the following high schools established courses dealing with the metal industries under the Smith-Hughes Act: Fresno; machine-shop and automobile repairing. Hollywood, Los Angeles; oil operation. Jefferson, Los Angeles; automobile repairing. Lincoln, Los Angeles; sheet-metal work, electrical work, and automobile mechanics. Manual Arts, Los Angeles; machine-shop. Polytechnic, Los Angeles; electrical work. San Pedro, Los Angeles; machine-shop, and machine-drafting. Vocational, Oakland; machine-shop, automobile repairing, electrical work, and pattern-making. Tamalpais, Marin county; machine-shop and electrical work. The total enrollment in these classes was 548 and the total amount of Federal and State aid was $8776.33. During the year ending June 30, 1919, the following additional courses were arranged in conformity with the Act: Gardena, Los Angeles; machine-shop. Hollywood, Los Angeles; automobile-truck repairing, machine-shop, and foundry. Jefferson, Los Angeles; machine drafting. Manual Arts, Los Angeles; automobile repairing, forge, foundry, and electrical work. Polytechnic, Los Angeles; machine-shop. San Pedro, Los Angeles; boat-building, welding, and automobile repairing. Torrance, Los Angeles county; metallurgy. Pomona; automobile repairing. Roseville, Sacramento county; machine-shop and boiler-making. San Jose, machine-shop. Stockton; machine-shop. Technical, Oakland; machine-shop, automobile repairing, electrical work, and pattern-making. Vocational, Oakland; forge. Statistics of the enrollment and the use of Federal and State funds are not yet available.

As the Oakland Technical High School and the Oakland Vocational High School are so far the only schools in the San Francisco Bay district to establish courses under the Smith-Hughes Act, a more detailed account of the work there will be given.

The work at the Technical High School is under the general charge of J. A. Robison. Besides the courses given this year a course in foundry work will be started during the coming school-year. Most of the articles produced and work done are for either the school itself or other schools in Oakland. Some work, however, is done for outsiders. All work, whether for the schools or for outsiders, is up to practical commercial standards. Graduates and former students who enter shops usually are able to reduce their apprenticeship time to a greater or less degree from the regular period. The school authorities, however, take no part in the determination of such reduction in apprenticeship time. It depends entirely on how the boy himself 'shows up' in the shop after leaving school. Full-time courses are the only ones given at this school. Cordial relations are maintained between the school authorities and both the commercial employers and the labor unions. Most of the instructors are experienced craftsmen, and several retain their union membership.

The work at the Vocational High School is in charge of W. A. Tenney, principal of the school. All courses are full-time. Earlier in the school year just closed, there was some demand for part-time co-operative courses

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among the boys and arrangements were made with some of the commercial shops accordingly, but no work of this kind is being given now. As with the Technical High School, most of the work is for the school itself, or for other schools, but some outside work is also taken. As a recent instance, a machinery house in San Francisco wanted to have a large amount of experimental work done on the design of one of its machines. The matter was explained to local union officials, who interposed no objections, and the work was done at the school, with satisfaction to all concerned. Reduction in apprenticeship time is usual with graduates and former students, but the amount of reduction depends entirely on the boy. In two instances last year, graduates of the school went to work directly as machinists, and made good. Whether this would have been possible under ordinary conditions of the labor market is doubtful.

In planning the work under the Smith-Hughes Act, in this State, Mr. Snyder and his associates have exerted every effort to make the courses really practical and such that the boys leaving the schools may have a good start at least toward becoming capable craftsmen. With all due recognition of the value of some of the industrial education of past years, it is a fact that much of the 'manual training' in both the grammar and the high schools was as far from real necessities as Milady's ballroom fan is from the one down in the engine-room that really does the work of ventilating. On the other hand, the applied work under the courses now being established are the real thing, whether they are given in the school shop or in a commercial one.

Applied work in courses under the Smith-Hughes Act must be practical.

Similarly, the so-called supplemental subjects are presented to the pupil in such a way as to keep the connection between them and the trade he is learning ever in his mind. His training in English includes study of trade and technical journals and books on related subjects. The work in physics, chemistry, and mathematics is directly connected with the industrial work. When the boy that is learning sheet-metal work is studying the calculation of the circumference of a circle from its diameter, the examples given him include such problems as the width of sheet needed to make pipe of a certain diameter. The work in hygiene and sanitation, besides personal hygiene, includes shop sanitation. The boys from these schools are not going to be satisfied with sanitary conditions in some of our industrial plants. The work in civics is concerned, not so much with the duties of the President, Congress, and other officials, as the civic duties, privileges, and responsibilities of ordinary citizens. A boy at one of these schools will learn that there are other and better ways of correcting abuses than putting a bomb under somebody's house.

The academic work in sciences and other subjects is planned with a view to its bearing on the trade being taught.

While most of the courses so far established have been full-time courses with the work done in the school shop, the State authorities are encouraging the making of arrangements with commercial shops so that the applied work, particularly in the fourth year of the courses, may be given as part of a regular apprenticeship in the commercial shop. Several schools have made arrangements of this kind, including the Roseville school, where excellent work is being done in connection with the Southern Pacific shops, and several of the Los Angeles schools. There seems to be some disagreement as to the best plan for arranging the supplemental and the applied work, whether half-day on and half-day off, week on and week off, or two weeks on and two weeks off. Where the half-day on and half-day off plan has been followed, and no instructor from the school has been sent into the shop with the boys, the result has been unsatisfactory from all standpoints, particularly the employer's. Where, however, as has been done at some of the Los Angeles schools, an instructor from the school goes with the boys into the shop and acts practically as their foreman, working of course in accord with the shop management, the result has been good. Where alternate week or alternate two-week periods are the rule, the success of the course does not depend so much on the providing of an instructor, although results in general appear to be better when this is done.

Part-time co-operative courses where the boy takes his applied work as part of a regular apprenticeship have been established in several schools.

Those who wish to follow the subject further are referred to the various bulletins of the Federal Board for Vocational Education, particularly Bulletin No. 1, already mentioned in this article, Bulletin No. 17, 'Trade and Industrial Education, Organization, and Administration', and Bulletin No. 19, 'Part-Time Trade and Industrial Education', also Bulletin No. 23-A of the California State Board of Education, and the Report of the State Commissioner of Industrial and Vocational Education for the two years ended June 30, 1918.

"THINGS seem crowded here in Switzerland."

"Yes, sir," said the landlord, "they are."

"All sorts of people about."

"Quite so, sir. Do you mind rooming with an exking?"

THE REPORTER, his fresh young face alight with enthusiasm, was interviewing the colored man who had lived 110 years. And the colored man, with fame perched on his doorstep, in a straw hat and with ready pencil, was doing his best.

"No sah," replied the colored centenarian plus. "Ah used to 'membah seein' Lincoln. But since I j'ned de African Methodist Church Ah doan' 'member seein' him no moah."

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The NC Type of Flying Boat

THE Navy flying boats used in the transatlantic flight were designed in the fall of 1917 by Rear Admiral D. W. Taylor, chief constructor of the Navy, who had in mind the development of a seaplane of the maximum size, radius of action, and weight-carrying ability for use in dealing with the submarine menace. Had the German submarines gained the upper hand in 1918, the War would have continued until now, and these great flying boats would have been produced in quantity and would have flown across the Atlantic to the centres of submarine activity. The first of the type was completed and given trials in October 1918. Their use now for a transatlantic attempt was strictly in line with the original purpose of the design and really in the nature of a service-trial.

The flying boats are designated NC, the N for Navy and C for Curtiss, indicating the joint production of the Navy and the Curtiss Engineering Corporation. Being designed for war service, the boats are not freak machines at all, but are rugged and comfortable craft designed and built in accordance with standard Navy practice.

The term flying boat is used for the NC type because it is actually a stout seaworthy boat that plows through rough water up to a speed of 60 miles per hour, and then takes to the air and flies at a speed of over 90 miles per hour.

The hull or boat proper is 45 ft. long by 10 ft. beam. The bottom is a double plank vee with a single step somewhat similar in form to the standard Navy pontoon for smaller seaplanes. Bulkheads divide the hull into six water-tight compartments, with water-tight doors in a wing passage for access. The forward compartment has a cockpit for the lookout and navigator. In the next compartment are seated side by side the principal pilot, or aviator, and his assistant. Next comes a compartment for the members of the crew off watch to rest or sleep. After this there are two compartments containing the gasoline-tanks (where a mechanician is in attendance), and finally a space for the radio man and his apparatus. The minimum crew consists of five men, but normally a relief crew would be carried in addition.

The hull has an easy flaring bow so that it can be driven through a seaway to get up the speed necessary to take the air and a strong vee-bottom to cushion the shock of landing on the water. The combination of great strength to stand rough water with the light weight required of anything that flies called for skill and care in design. The bare hull, ready for installation of equipment, weighs only 2800 lb., yet the displacement is 28,000 lb. This lightness of construction was attained by a careful selection and distribution of materials. The keel is of Sitka spruce, as is the planking. Longitudinal strength is given by two girders of spruce braced with steel wire. To ensure water-tightness and yet keep the planking thin, there is a layer of muslin set in marine glue between the two plies of planking.

The wings are of a curvature known from experience to be efficient, designated as R. A. F. 6, and carry a load of 11.7 lb. per square foot in the air, but the structural weight is only 1.2 lb. per square foot. The total area is 2380 square feet.

The main wing-spars are hollow spruce boxes. Each rib is a truss designed like a bridge, consisting of continuous cap-strips of spruce, tied together by an internal web-system of vertical or diagonal pieces of spruce. The ribs are 12 ft. long, but only weigh 26 oz. each. On test these ribs were required to carry a load of 450 lb. of sand for 24 hours without damage.

The diagonal bracing between wings is by means of steel cables in pairs. These cables are arranged to lie one behind the other with a spruce batten between to reduce air resistance.

The tail in this craft is unique and resembles no other flying machine or animal. The tail-surface resembles that of a biplane of the general appearance and size of the usual aeroplane. Indeed, this tail of over 500 sq. ft. area is twice as large as the single-seater fighting aeroplane used by the Army. The tail-structure is supported by three hollow spruce booms braced by steel cable in such a way as to remain clear of all breaking seas and to permit a machine-gun to be fired straight aft from the stern compartment without interference. The method of support is a radical change from former American and foreign practice and gives several advantages, including an important saving in weight.

The four Liberty engines that drive the boat are mounted between the wings. Each engine develops 400 hp. One engine with a tractor propeller is mounted on each side of the centre line, and on the centre line the two remaining engines are mounted one behind the other. The front engine has a tractor propeller and the rear engine a pusher propeller. This arrangement of engines is novel and has the advantage of concentrating weight near the centre of the boat.

The steering and control in the air are arranged in principle exactly as in a small aeroplane, but it was not an easy problem to make it possible for this 14-ton boat to be handled by one man of only normal strength. To ensure easy operation, each control surface was carefully balanced in accordance with experiments made in a wind-tunnel on a model. The operating cables are run through ball-bearing pulleys and all avoidable friction eliminated. Finally the entire craft is so balanced that the machine is inherently stable in flight. As a result the boat will fly herself, and will continue on her course without the con-

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stant attention of the pilot. However, if he wishes to change course, a slight pressure of his controls is enough to swing the boat promptly. There is provision, however, for an assistant to the pilot to relieve him in rough air if he becomes fatigued or wishes to leave his post to move about the boat.

A feature of this boat that is new is the use of welded aluminum tanks for gasoline. There are nine 200-gal. tanks made of sheet aluminum with welded seams. Each tank weighs only 70 lb., about one-half the weight of a sheet-steel or copper tank.

The NC flying boat weighs when fully loaded 28,000 lb., and when empty, but including radiator water and fixed instruments and equipment, 15,874 lb. The useful load available for crew, supplies, and fuel is, therefore, 12,126 lb., or over 43%. This useful load may be divided among fuel, explosives, freight, or crew, in any proportion desired. For an endurance flight there would be a crew of five men (850 lb.) radio and radio telephone (220 lb.), food, water, signal lights, spare parts and miscellaneous equipment (524 lb.), oil (750 lb.), gasoline (9650 lb.) This should suffice for a flight of 1400 nautical miles. The radio outfit is of sufficient power to communicate with ships 200 miles away. The radio telephone can be used to talk to other planes in the formation or within 25 miles.

Other dimensions and characteristics of the NC type may be summarized as follows: Span, 126 ft. upper and 94 ft. lower; length, 68 ft. 5½ in.; height, 24 ft. 5⅛ in.; fuel-tanks, 1800 gal. capacity; oil-tanks, 160 gal. capacity; maximum speed, 74 knots for 28,000 lb.; minimum speed, 58 knots for 28,000 lb.; maximum speed, 84 knots for 24,000 lb.; minimum speed, 55 knots for 24,000 pounds.

GROUP INSURANCE

By JOHN R. BROWNELL*

WHAT is group insurance, what are its aims, and what results may be expected from its operation?

It is, simply stated, the insurance of the lives of all the employees of a company or corporation under a blanket policy, without individual medical examination, the premiums being paid entirely by the employer and the insurance being payable to whomever the employee names. Individual certificates are given to each employee, bearing his name, along with the name of the beneficiary. A natural inquiry will be regarding the lack of requirement for medical examination. It should, however, be stated that a careful inspection is made of the environment of the employees, conditions of ventilation, drinking-water, sanitary arrangements, mechanical safeguards, and the like, before the rate to be charged is fixed. It has been found to be safe, from the actuary's standpoint, to accept a group on this basis, for, although there may be a few who could not pass a medical examination, yet, taken as a whole, a group of employees engaged in active work in the same class of industry will prove to be good risks. It is, however, true that group insurance does actually permit some to obtain life-insurance protection, even though they would be otherwise debarred.

Ordinarily, the amount of insurance carried on each life under the group-plan is dependent upon the length of employment, a commonly used period of six months being used as the starting point, with from $500 to $1000 as the initial amount, which is often increased by annual increments up to a maximum of $3000. In some cases, a full year's salary has been the amount carried, with the stipulation that in case of death the beneficiary will receive twelve monthly payments, thus giving a year's warning, so to speak, of the loss of earnings. Insurance under the group plan ceases with termination of employment, and new incoming employees are automatically included after passing a simple health test.

In its aims, group insurance is substantially welfare work, primarily for the benefit of the employed, and secondarily for the benefit of the employer. It aims also to create a definite tie between the home and the job, and to foster a feeling of loyalty that can be obtained in no other way.

In its application, group insurance may be expected to obtain three definite results. First, more contented, cheerful workers; second, better working conditions, due to the 'merit rating' feature of the premium costs; third, and probably the most important, in reducing labor turnover, which is an ideal sought by all employers. A man will hesitate to do poor work, and will not as readily quit his job if he knows that his insurance policy will be worthless if he should do so. In addition many cases of distress will be relieved, in instances where death occurs.

Many of the largest employers of labor have recently adopted the group plan of insurance, some important concerns being the following:

Union Pacific System, The Goodrich Co., Standard Oil Co. of New Jersey, Du Pont Powder Co. and over a dozen subsidiary companies, Studebaker Corporation, California Packing Corporation, Blake, Moffitt & Towne, San Francisco Savings & Loan Society, Roos Bros., and H. O. Harrison Co., the last five companies being in the San Francisco Bay district.

*San Francisco Manager, Group Insurance Department, Equitable Life Assurance Society.

A TRANSPORT carrying negro members of a labor battalion was pulling into a French port.

One big darky, leaning over the rail, watched the harbor scenes. Spying a Frenchman fishing in a little skiff, he shouted:

"Hey, you French boy! Here I come 3000 miles from Alabama to fight for you and I find you out fishin'. Where do you get that stuff at?"

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The Care of Transformers

By R. W. A. BREWER*

The majority of users of transformers do not fully appreciate the necessity for giving regular care and attention to the transformer oil. Recent experiences that I have had in the course of my work as a mechanical and electrical inspector have brought me more closely in touch with the popular attitude toward transformers than heretofore.

Oil is used in transformers and similar apparatus and in electrolytic arresters as an insulating and cooling medium. For transformers, it should have the following characteristics:

1. High dielectric strength.
2. High flash-point.
3. Low viscosity to allow free circulation for cooling.
4. Freedom from deposit and acid or alkali.
5. Absolute freedom from moisture.

For use in circuit-breakers and arresters it should have the same characteristics except that for circuit-breakers it must have high viscosity to prevent splashing and for arresters it must have high viscosity to permit the formation of a sufficiently heavy oil-film.

From the maintenance point of view, when once a suitable oil has been selected a regular system of inspection, testing, filtering, and replenishing should be undertaken, particularly in large installations. This is especially necessary to guard against absorption of moisture or collection of acid or dirt in the oil. Before placing it in the transformer, oil should be carefully strained through two or three thicknesses of fine gauze, which has first been thoroughly washed. The oil itself should not be stored out-of-doors nor in drums end-up in such a position as to allow water to collect around the bung. Cans or barrels should not be opened before the oil is actually needed, otherwise moisture is likely to get into the oil. In the course of working, regular inspections should include:

1. A check on the oil-level, any loss by evaporation being replaced.

2. An examination of samples from the bottom of the apparatus for sediment or discoloration. Deposit on any surface except the base should not exceed $\frac{1}{8}$ in. thick. The remedy for dirty apparatus is to cleanse it thoroughly by forcing dry clean oil through all the passages and against all the surfaces.

3. The dielectric strength should be tested regularly. If this is low, the oil should be filtered by means of suitable apparatus, which can be purchased for this purpose. The proportion of water should not exceed 1 part in 100,000 to pass the standard test for all high-tension work. This examination should be made every three months with out-of-door apparatus.

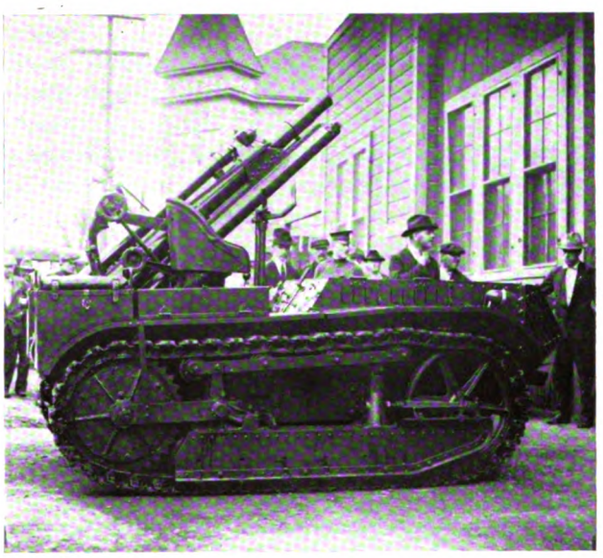
Suitable filter-presses consisting of frames carrying sheets of blotting paper mounted complete with a circulating-pump can be attached to transformers so that the oil can be circulated and dried without stopping the transformer from working. Such filters are strongly to be recommended, particularly in a damp climate.

The oil-level should be watched. As the oil is used as a cooling medium, all of the active windings should be kept covered. If this is not done undue local heating may occur in the upper windings and cause evaporation of the lighter fractions of the oil. This will still further increase the evaporation and the danger of serious damage and fire.

*Consulting engineer, 503 Market street, San Francisco.

Gun-Carriage With 'Caterpillar' Traction

The accompanying illustration shows a new 'caterpillar' gun-carriage recently completed by the Holt Manufacturing Co. of Stockton, and shipped to the



TRACTOR GUN-CARRIAGE

Presidio at San Francisco for trial. The gun is the new regulation 75-millimetre field-piece, and is arranged for both anti-aircraft and ordinary work. The carriage has an eight-cylinder automobile-engine, and a speed of 15 miles per hour can be developed.

In Massachusetts there is a scheme advanced permitting some of the shop-crew to serve on the board of directors, and any guy what says California starts all the food legislation had better move to Mass.

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The Shop Committee System*

By L. P. ALFORD

THE shop-committee system is a new development. The oldest committee was started in 1903 and most of them were not formed until 1918. Bridgeport alone has 44 plants where this system is in force. The plan devised by H. F. J. Porter in 1903 at the plant of the Nernst Lamp Co. at Pittsburgh was described by him in 'The Engineering Magazine' in August 1905. This committee was composed of secretly elected employees under the chairmanship of the shop superintendent. Conditions in the plant that might be bettered for the employees were discussed, and the committee evidenly functioned as a safety-first committee as well as a representative shop committee.

Without doubt the success of the safety committees, with which there has been six or seven years of experience, has paved the way in many plants for the representative shop committee. In fact, a prediction of this development is found in a paper presented before this Society in 1915 written by W. H. Cameron.

A general classification of these shop-committee plans shows three types:

The first provides for an organization roughly paralleling the Cabinet, Senate, and House of Representatives of the Federal government. The Cabinet may consist of some or all of the directors or higher executives of the plant. The Senate may consist of all or part of the foremen, while the House of Representatives is a body secretly elected by the employees.

A second type divides the workers in the plants into divisions, each having a definitely determined and equal number of employees, not necessarily defined according to craft or occupation. Any one division may include employees from several trades and doing varying kinds of work. Each division elects its own representative secretly, and these representatives coming together form the shop committee. This plan is simple, but is not adapted to industries where there is a high degree of organization or where the workers naturally divide into a series of recognized trades.

The third plan is the one adopted by the National War Labor Board and installed under its direction in a number of plants making war materials. Its essential features are outlined in the following official statement of procedure for election:

"Shop committees shall be selected to meet with an equal or lesser number of representatives to be selected by the employer. Each department or section of the shop shall be entitled to one committee-man for each one hundred employees employed in the department or section. If in any department or section there shall be employees in excess of an even hundred, then an additional committee-man may be elected providing the additional employees beyond the even hundred shall be fifty or more; if less than fifty no additional representation shall be allowed. As an example: In a department or section employing 330 men, three committee-men will be elected; in a department employing 375 men, four committee-men will be elected."

In plants where shop committees have been in operation for some time, a wide variety of topics has been submitted for discussion and determination. One grouping lists 42 different subjects for discussion, of which only one was wages. The plans are too new to estimate the extent of the effect they may have in developing good industrial relations. A sufficient amount of experience has, however, already been accumulated to indicate that the application of the ideas of joint consideration and control on the part of employers and employees will produce favorable results. To reach a workable basis, the employer must voluntarily limit his own authority and agree to conduct his business by the rule of reason and even-handed justice as interpreted by the representative shop committee that he may establish. The plan seems to restore, so far as possible in a large-scale business, the simple and effective relationship that used to exist between the master and skilled workman, and which largely exists even today between the small employer and his half-dozen employees.

A rather more formal mechanism for establishing representation in industry is the protocol system worked out in the coat-and-suit trade in New York City, and which has been applied in a few other instances in similar trades.

From one viewpoint the rapidly developing movement to put shop committees into effect in the United States is a confession on the part of employers and those who have the responsibility for industrial enterprises that they have already lost some of their control. Under such conditions there is a readiness to experiment. From another viewpoint it is an earnest attempt to find a basis for good-will and democratic co-operation in the control of industry.

A parallel movement has taken place in Great Britain leading to the proposal to establish industrial councils through which the British government may promote effective co-operation between the organized employers and workers, believing that representative government in industry will foster good relations between employers and employed.

*Extract from paper on 'The Status of Industrial Relations' presented at the Detroit meeting of the American Society of Mechanical Engineers, June 1919.

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Manganese-Bronze*

By W. C. PHALEN

MANGANESE-BRONZE made its first appearance about 1876. Its name is somewhat misleading, for the alloy contains only a small proportion of manganese. Indeed, it is simply a brass to which have been added, by proper methods of alloying, small quantities of aluminum, iron, or manganese with the view to strengthening the alloy and making it denser and closer-grained than the average yellow-brass casting.

Manganese-bronze should not contain much manganese, in fact not more than 0.05% in high-grade bronze. The consumption of manganese, therefore, in such alloys is small. The object of the manganese is not so much to act as an ingredient of the alloy, but to serve as a carrier of the iron that must be present to ensure the required strength and elastic limit. The manganese in the alloy serves one purpose only, namely, to introduce the iron, for without the manganese the iron would not alloy with the copper. It is added usually in the form of ferro-manganese. If manganese is used in large quantities it hardens the alloy, but not nearly to the degree produced by iron; such an addition also lowers the elastic limit. Aluminum imparts good sand-casting properties to the bronze.

There are two grades of manganese-bronze now in common use. One is a mixture used for rolling into sheets or drawing into wire or tubes and for forging. This contains no aluminum, has slightly less zinc than the other, and cannot be cast in sand. The second alloy is used for sand-casting and is the one employed in making propellers and other common appliances.

P. E. McKinney† describes a process of manufacturing manganese-bronze wherein by-products and scrap are used instead of virgin metals and raw materials of the highest purity.

The composition of manganese-bronze is as follows:

	%
Copper	57.00–59.00
Zinc	38.00–40.00
Iron, manganese, aluminum, and tin	0.25– 1.00
Lead	0.10– 0.50

It is apparent that there is no particular necessity for the use of high-grade materials, provided the finished product is properly refined. Among the low-grade materials suggested are the following: Skimmings from the foundry, especially skimmings and dross ordinarily recovered from brass-rolling mills or cartridge-case plants; zinc-dross recovered from galvanizing plants; aluminum turnings that are generally unrecoverable without serious loss and deterioration of product from oxidation and other causes; and other by-products and scrap metals that ordinarily are not usable as re-melting scrap in foundry practice.

High-grade manganese-bronze cannot be made from the above raw materials on a small scale. Consequently, crucible furnaces cannot be used. A reverberatory furnace or other equipment with which a bath of considerable proportion may be employed is required. Mr. McKinney discusses a typical charge, the materials being melted in the presence of charcoal, using salt as a flux.

The most important use of manganese-bronze is in propeller-blades. A strong tough alloy that will resist the action of sea-water is necessary. The blades are made thin to save weight.

*Extract from report to Bureau of Mines on 'Use of Manganese Other Than for Steel-Making'.

†See 'Metal Trades', March 1919, p. 127.

Hardness of Alloys of Non-Ferrous Metals

In the 'Zeitschrift des Vereines Deutcher Ingenieure', P. Ludwik describes a series of experiments on the effect of varying composition upon the hardness of an alloy. For copper-tin alloys, the hardness increases with the percentage of tin, slowly at first, and then more rapidly. An alloy containing 1% of tin is 10% harder than pure copper. Bronzes containing 10%, 15%, and 20% of tin are, respectively, twice, three times, and four times as hard as pure copper. Annealing these alloys makes little difference in the hardness. Adding lead decreases the hardness slightly, and adding zinc slightly increases it.

The hardening effect of aluminum upon copper is not quite so great as that of tin for the smaller percentages. An aluminum-copper alloy containing 8% aluminum is just about as hard as a tin-copper alloy containing 8% tin. Above 8%, however, the hardening effect of aluminum increases rapidly, and an alloy containing 15% aluminum is twice as hard as one containing 15% tin.

The hardening effect of zinc on copper is not so great as that of either tin or aluminum, 30% of zinc having about the same effect as 4% of tin. Large quantities of lead soften brass, while iron makes it harder. Tin and aluminum both increase the hardness of brass to a greater extent than they do pure copper. In the case of tin, this hardness is produced at the expense of ductility. All this latter class of alloys are rendered much softer by annealing. Nickel and manganese both have a hardening effect upon copper, although much less than either tin or aluminum. Annealing has no appreciable effect on the hardness of alloys of copper with either nickel or manganese. Magnesium has a greater hardening effect upon copper and its alloys than any other substance.

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Duralumin and Its Heat Treatment*

Duralumin was developed about 1911 by A. Wilm. Its usual composition is as follows:

	%		%
Copper	3 to 4.5	Iron (as impurities)	0.4 to 1.0
Magnesium	0.4 to 1.0	Silicon	0.3 to 0.6
Manganese	0.0 to 0.7	Aluminum	Remainder

It weighs about 178 lb. per cubic foot. Its tensile strength after the proper heat treatment is from 50,000 to 60,000 lb. per square inch. It is used only in the forged or rolled condition. Its principal use is for parts where both strength and light weight are required.

The most remarkable property of duralumin is the fact that it can be hardened appreciably by quenching from temperatures below its melting point, followed by aging at ordinary temperatures, which aging consists merely of allowing the material to stand at these temperatures. The hardness is not produced by the quenching alone, but increases during the period of aging, which may be from one to three days. Upon annealing, the alloy so hardened is softened exactly as is hardened steel.

The authors of this paper carried on experiments in the heat treatment of duralumin, partly in the laboratories of the Bureau of Standards and partly in co-operation with the Aluminum Company of America at its laboratories at South Kensington. The conclusions are as follows:

When duralumin is cooled rapidly by quenching from temperatures between 250° and 520°C., and then aged at temperatures from 0° to 200°C. the hardness, and, at least at lower aging temperatures, the ductility increases. The actual values of hardness and ductility thus obtained depend on the quenching-temperatures. For the best results, the quenching temperature should be between 510° and 515°C. and should not exceed 520°C. under any circumstances. Sheet material should be held at this temperature from 10 to 20 minutes. Heavier sections, such as bars, might require a longer time.

Quenching is best done in boiling water, the resultant mechanical properties being better than if cold water is used. There is also less danger of cracking from cooling-stresses.

The best temperature for the subsequent aging depends on the mechanical properties desired. For most purposes it will be best to age at 100°C. for 5 or 6 days. Such a treatment develops both high strength and high ductility. If a material having a higher proportional elastic limit, but lower ductility is desired, it may be aged at temperatures up to 150°C. for 2 to 4 days.

The authors believe that it would be of advantage to pre-heat the ingots for hot-rolling at a somewhat higher temperature than is sometimes used, say 500°C. Rolling should, however, be done at about 450°C., as there is danger of hot-shortness if the material is rolled at the higher temperature.

*Abstract of paper to be presented at the Chicago meeting of the American Institute of Mining and Metallurgical Engineers, by P. D. Merica, R. G. Waltenberg, and H. Scott.

This Notice Appeals

In the psychology of persuasion, the first principle is that a person is most interested in that which directly concerns himself, or in what comes within the range of

his experience. This cleverly worded notice takes advantage of the above principle, making a direct appeal to the employee by subtly suggesting an empty pay-envelope. This notice is to be seen in the Anaconda plant, at Butte.

Must Wear Pants!

'El Universal', the leading newspaper of the City of Mexico, has this remarkable dispatch:

MORELIA, MEX., April 21.—The Mayor, Senor Idalecio Contreras, has just issued a public order by which he makes obligatory the wearing of pants by the male residents and visitors when passing through the streets of the town. The order directs that all persons who do not possess these articles of wearing apparel must provide themselves with these not later than May 5. Failure to comply with the order is punishable and the offender must secure pants before being released from custody. The Mayor specifies that the use of underwear will not be regarded as complying with the order.

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The Efficient Compression of Air

By CHARLES A. HIRSCHBERG

*Economical and efficient operation of air-compressors demands regular inspection. The compressor as a whole should be inspected at least once a month, making necessary adjustments, such as taking-up of packing-glands and replacement of worn parts. Air-valves should be examined and should show an oily surface free from carbon. Ports and passages also should be examined for carbon or other obstructions. Carbon deposit on valves prevents their seating properly, causes leakage and results in reduced compressor-capacity and low efficiency. Obstructions in air-passages reduce their area and cause loss in friction. A carbon deposit, in combination with high temperature, due to improper cylinder cooling, sticking of valves, or insufficient lubrication, may result in explosions, if allowed to persist. Remove any carbon deposited.

The use of packing is often misunderstood. Drawing up too tightly will cause heating, and scoring of the piston-rod. This means higher temperatures and increased mechanical friction, with transmitting of increased temperature to the air cylinder, causing trouble from moisture, lowering the air density, and thereby reducing the output.

In placing the packing in a stuffing-box, put the rings in so that the joints of the several rings stagger. Fill the box without crowding, and with new packing force in slightly with the gland until the compressor warms up; then draw up just enough to prevent blowing. Crowding the packing will squeeze-out the lubricant it contains, causing the packing to become hard and unyielding. If upon examination packing is found to be hard, it may be revived by removing, loosening up, and working in a mixture of graphite and grease. Asbestos-sheet packing is generally used between cylinder-heads and cylinders. If for any reason it becomes necessary to remove a head, care should be exercised not to injure this head-gasket. If necessary to replace it, be sure to use material of the same thickness as the original, so as to maintain the clearance established by the builder.

Do not have the air-intake open to the engine-room. Carry it outdoors and extend upward a sufficient height, with hood and screen, to prevent foreign substances from being drawn-in and to ensure cool intake air. Fig. 1 shows an ideal method of handling the air-intake. Take the air into the compressor as cool as possible is the rule without any exception. Cooling the intake air is a direct saving of power by reducing the volume to be compressed. The capacity of the air to hold moisture falls off rapidly as its temperature is reduced.

*Abstract from 'Power Plant Engineering' and 'Compressed Air Magazine'.

Pipe-lines should be of ample size, as small transmission-lines mean excessive loss of pressure due to friction. Large pipe-lines are especially desirable where the pipes are long or the supply has to meet the demands of a great many devices. Reduced pressure due to friction means inefficient operation of tools. The accompanying chart, Fig. 2, covering loss in pressure due to friction in pipe-lines, will serve to indicate the need for having the pipe-line of ample size. Take, for example, the following case:

The loss in pressure in transmitting 50 cu. ft. of free air per minute at 100 lb. pressure through 1000 ft. of 1-in. pipe is 11.89 lb., and only 0.27 lb. in transmitting the same volume of air the same distance through a 2-in. pipe.

Air-lines should receive monthly inspection for leaks. Assuming that 1 cu. ft. of air per minute at 100 lb. pressure costs $5 per year, this cost being computed from an estimated charge for electricity at 1c. per kw-hr., interest and depreciation at 10%, and a year as 300 eight-hour days, the following demonstrates the economy of regular pipe-line inspections:

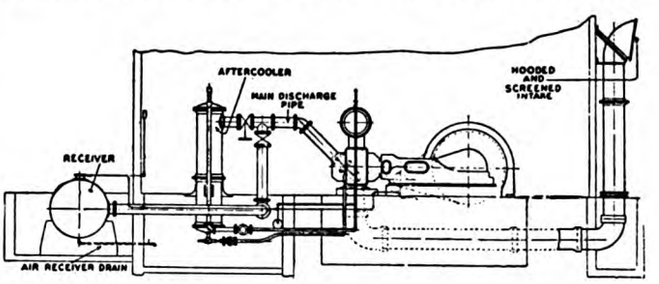

FIG. 1. PROPER ARRANGEMENT OF AIR-INTAKE AND PIPING

Amount of Leak in Cubic Feet

Diameter of hole, inches	Free air per minute	Cost per year
1/16	6.45	$32
1/32	1.61	8
1/64	0.40	2

Further calculations of possible loss through leaks may be quickly made by applying the above constant to the various discharge volumes shown in Fig. 3.

It is always advisable to provide numerous outlets in the transmission-line. This will have future reconstruction, and make it possible to use comparatively shorter lengths of hose. Where a number of supply-lines radiate from the main line, it is well to provide a gate-valve for cutting out any of these lines when they are to be idle for any considerable period of time.

Several methods are used of detecting air leaks: By the use of a lighted candle at all joints and connections, by swabbing soapy water around the joints, or by fol-

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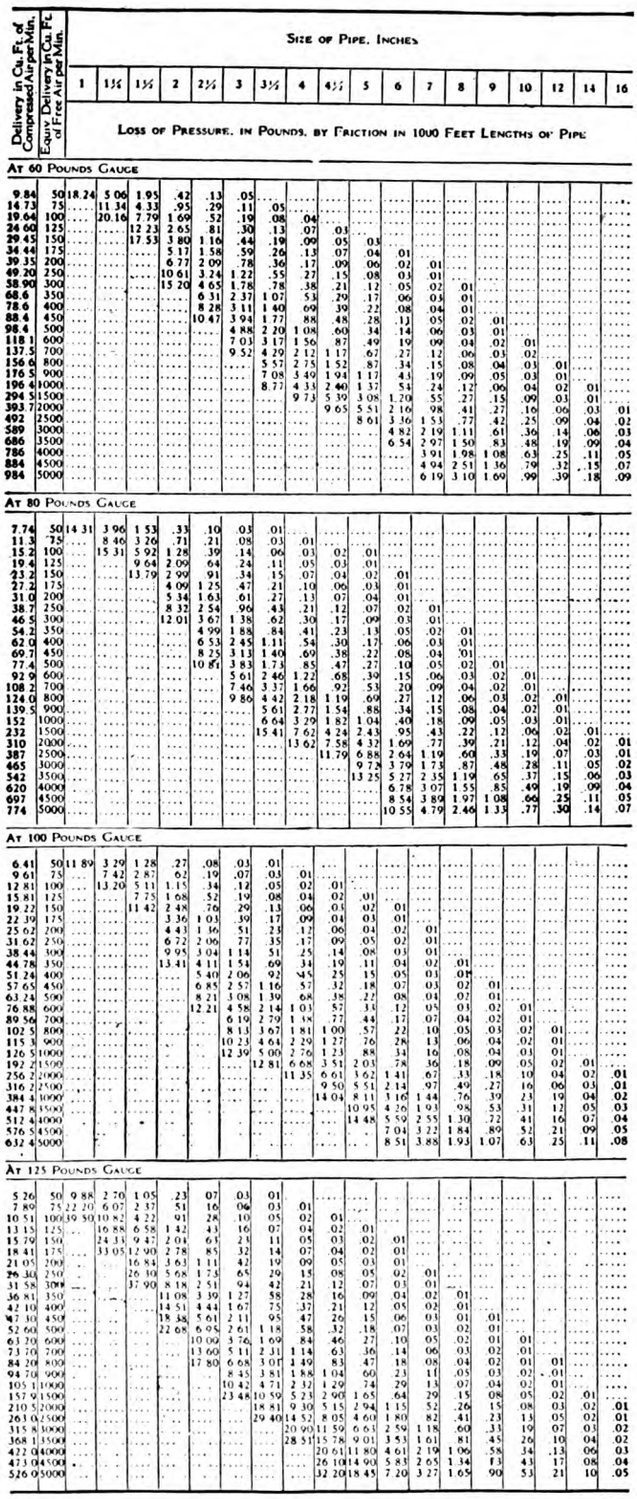
lowing the practice of one Illinois manufacturer, who, at regular intervals, put essence of peppermint into the air system and then has all the pipes inspected. Leaks are revealed by the odor.



Delivery in Cu. Ft. of Compressed Air per Min.	Equiv. Delivery in Cu. Ft. of Free Air per Min.	Size of Pipe, Inches: 1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	16
		Loss of Pressure, in Pounds, by Friction in 1000 Feet Lengths of Pipe																	
At 60 Pounds Gauge																			
9.84	50	18.24	5.06	1.95	.42	.13	.05												
14.73	75		11.34	4.33	.95	.29	.11	.05											
19.64	100		20.16	7.79	1.69	.52	.19	.08	.04										
24.60	125			12.23	2.65	.81	.30	.13	.07	.03									
29.45	150			17.53	3.80	1.16	.44	.19	.09	.05	.03								
34.44	175				5.17	1.58	.59	.26	.13	.07	.04	.01							
39.35	200				6.77	2.09	.78	.36	.17	.09	.06	.02	.01						
49.20	250				10.61	3.24	1.22	.55	.27	.15	.08	.03	.01						
58.90	300				15.20	4.65	1.78	.78	.38	.21	.12	.05	.02	.01					
68.6	350					6.31	2.37	1.07	.53	.29	.17	.06	.03	.01					
78.6	400					8.26	3.11	1.40	.69	.39	.22	.08	.04	.01					
88.4	450					10.47	3.94	1.77	.88	.48	.28	.13	.05	.02	.01				
98.4	500						4.88	2.20	1.08	.60	.34	.14	.06	.03	.01				
118.1	600						7.03	3.17	1.56	.87	.49	.19	.09	.04	.02	.01			
137.5	700						9.52	4.29	2.12	1.17	.67	.27	.12	.06	.03	.02			
156.6	800							5.57	2.75	1.52	.87	.34	.15	.08	.04	.03	.01		
176.5	900							7.08	3.49	1.94	1.17	.43	.19	.09	.05	.03	.01		
196.4	1000							8.77	4.33	2.40	1.37	.54	.24	.12	.06	.04	.02	.01	
294.5	1500								9.73	5.39	3.08	1.20	.55	.27	.15	.09	.03	.01	
393.7	2000									9.65	5.51	2.16	.98	.44	.27	.16	.06	.03	.01
492	2500										8.61	3.36	1.53	.77	.42	.25	.09	.04	.02
589	3000											4.82	2.19	1.11	.61	.36	.14	.06	.03
686	3500											6.54	2.97	1.50	.83	.48	.19	.09	.04
786	4000												3.91	1.98	1.08	.63	.25	.11	.05
884	4500												4.94	2.51	1.36	.79	.32	.15	.07
984	5000												6.19	3.10	1.69	.99	.39	.18	.09
At 80 Pounds Gauge																			
7.74	50	14.31	3.96	1.53	.33	.10	.03	.01											
11.3	75		8.46	3.26	.71	.21	.08	.03	.01										
15.2	100		15.31	5.92	1.28	.39	.14	.06	.03	.02	.01								
19.4	125			9.64	2.09	.64	.24	.11	.05	.03	.01								
23.2	150			13.79	2.99	.91	.34	.15	.07	.04	.02	.01							
27.2	175				4.09	1.25	.47	.21	.10	.06	.03	.01							
31.0	200				5.34	1.63	.61	.27	.13	.07	.04	.01							
38.7	250				8.32	2.54	.96	.43	.21	.12	.07	.02	.01						
46.5	300				12.01	3.67	1.38	.62	.30	.17	.09	.03	.01						
54.2	350					4.99	1.88	.84	.41	.23	.13	.05	.02	.01					
62.0	400					6.53	2.45	1.11	.54	.30	.17	.06	.03	.01					
69.7	450					8.25	3.13	1.40	.69	.38	.22	.08	.04	.01					
77.4	500					10.81	3.83	1.73	.85	.47	.27	.10	.05	.02	.01				
92.9	600						5.61	2.46	1.22	.68	.39	.15	.06	.03	.02	.01			
108.2	700						7.66	3.37	1.66	.92	.53	.20	.09	.04	.02	.01			
124.0	800						9.86	4.42	2.18	1.19	.69	.27	.12	.06	.03	.02	.01		
139.5	900							5.61	2.77	1.54	.88	.34	.15	.08	.04	.02	.01		
152	1000							6.64	3.29	1.82	1.04	.40	.18	.09	.05	.03	.01		
232	1500							15.41	7.62	4.24	2.43	.95	.43	.22	.12	.06	.02	.01	
310	2000								13.62	7.58	4.32	1.69	.77	.39	.21	.12	.04	.02	.01
387	2500									11.79	6.88	2.64	1.19	.60	.33	.19	.07	.03	.01
465	3000										9.72	3.79	1.73	.87	.48	.28	.11	.05	.02
542	3500										13.25	5.27	2.35	1.19	.65	.37	.15	.06	.03
620	4000											6.78	3.07	1.55	.85	.49	.19	.09	.04
697	4500											8.54	3.89	1.97	1.08	.66	.25	.11	.05
774	5000											10.55	4.79	2.46	1.33	.77	.30	.14	.07
At 100 Pounds Gauge																			
6.41	50	11.89	3.29	1.28	.27	.08	.03	.01											
9.61	75		7.42	2.87	.62	.19	.07	.03	.01										
12.81	100		13.20	5.11	1.15	.34	.12	.05	.02	.01									
15.81	125			7.75	1.68	.52	.19	.08	.04	.02	.01								
19.22	150			11.42	2.48	.76	.29	.13	.06	.03	.02	.01							
22.39	175				3.36	1.03	.39	.17	.09	.04	.03	.01							
25.62	200				4.43	1.36	.51	.23	.12	.06	.04	.02	.01						
31.62	250				6.72	2.06	.77	.35	.17	.09	.05	.02	.01						
38.44	300				9.95	3.04	1.14	.51	.25	.14	.08	.03	.01						
44.78	350				13.41	4.11	1.54	.69	.34	.19	.11	.04	.02	.01					
51.24	400					5.40	2.06	.92	.45	.25	.15	.05	.03	.01					
57.65	450					6.85	2.57	1.16	.57	.32	.18	.07	.03	.02	.01				
63.24	500					8.21	3.08	1.39	.68	.38	.22	.08	.04	.02	.01				
76.88	600					12.21	4.58	2.08	1.02	.57	.33	.11	.07	.04	.02	.01			
89.56	700						6.19	2.79	1.38	.77	.44	.17	.07	.04	.02	.01			
102.5	800						8.13	3.67	1.81	1.00	.57	.22	.10	.05	.03	.02	.01		
115.3	900						10.23	4.64	2.29	1.27	.76	.28	.13	.06	.04	.02	.01		
126.5	1000						12.39	5.00	2.76	1.23	.88	.34	.16	.08	.04	.01	.01		
192.2	1500							12.81	6.68	3.51	2.03	.74	.35	.18	.08	.05	.02	.01	
256.2	2000								11.35	6.61	3.62	1.41	.67	.33	.18	.10	.04	.02	.01
316.2	2500									9.50	5.51	2.14	.97	.49	.27	.16	.06	.03	.01
384.4	3000									14.04	8.11	3.16	1.44	.76	.39	.23	.19	.04	.02
447.8	3500										10.95	4.26	1.91	.98	.53	.31	.12	.05	.03
512.4	4000										14.48	5.59	2.55	1.30	.72	.41	.16	.07	.04
576.5	4500											7.04	3.22	1.84	.89	.52	.21	.09	.05
632.4	5000											8.51	3.88	1.93	1.07	.63	.25	.11	.08
At 125 Pounds Gauge																			
5.26	50	9.88	2.70	1.05	.23	.07	.03	.01											
7.89	75	22.20	6.07	2.37	.51	.16	.06	.03	.01										
10.51	100	39.50	10.82	4.22	.91	.28	.10	.05	.02	.01									
13.15	125		16.88	6.58	1.42	.43	.16	.07	.04	.02	.01								
15.79	150		24.33	9.47	2.04	.61	.23	.11	.05	.03	.02	.01							
18.41	175		33.05	12.90	2.78	.85	.32	.14	.07	.04	.02	.01							
21.05	200			16.84	3.63	1.11	.42	.19	.09	.05	.03	.01							
26.30	250			26.30	5.68	1.73	.65	.29	.15	.08	.05	.02	.01						
31.58	300			37.90	8.18	2.51	.94	.42	.21	.12	.07	.03	.01						
36.81	350				11.08	3.39	1.27	.58	.28	.16	.09	.04	.02	.01					
42.10	400				14.51	4.44	1.67	.75	.37	.21	.12	.05	.02	.01					
47.30	450				18.38	5.61	2.11	.95	.47	.26	.15	.06	.03	.01	.01				
52.60	500				22.68	6.95	2.61	1.18	.58	.32	.18	.07	.03	.02	.01				
63.20	600					10.00	3.76	1.69	.84	.46	.27	.10	.05	.02	.01	.01			
73.70	700					13.60	5.11	2.31	1.14	.63	.36	.14	.06	.03	.02	.01			
84.20	800					17.80	6.68	3.07	1.49	.83	.47	.18	.08	.04	.02	.01	.01		
94.70	900						8.45	3.81	1.88	1.04	.60	.23	.11	.05	.03	.02	.01		
105.1	1000						10.42	4.71	2.32	1.29	.74	.29	.13	.07	.04	.02	.01		
157.9	1500						23.48	10.59	5.23	2.90	1.65	.64	.29	.15	.08	.05	.02	.01	
210.5	2000							18.81	9.30	5.15	2.94	1.15	.52	.26	.15	.08	.03	.02	.01
263.0	2500							29.40	14.52	8.05	4.60	1.80	.82	.41	.23	.13	.05	.02	.01
315.8	3000								20.93	11.59	6.61	2.59	1.18	.60	.33	.19	.07	.03	.02
368.1	3500								28.51	15.78	9.01	3.53	1.61	.81	.45	.26	.10	.04	.02
422.0	4000									20.61	11.80	4.61	2.19	1.06	.58	.34	.13	.06	.03
473.0	4500									26.10	14.90	5.83	2.65	1.34	.73	.43	.17	.08	.04
526.0	5000									32.20	18.45	7.20	3.27	1.65	.90	.53	.21	.10	.05

FIG. 2. LOSS OF AIR-PRESSURE IN PIPE TRANSMISSION

Pipe-lines may be tested for loss of pressure due to friction in transmission or to leakage by placing an air-gauge at the point of use of the air, and comparing its reading with that of the gauge on the air-receiver. The remedies are increasing the size of the air-line and eliminating of leaks.

All air contains moisture. When compressed, the moisture becomes more evident, as in the compressed state there is more water in the air than it can contain. The excess moisture is deposited almost immediately as the air travels to the receiver; part of it travels with the air through the transmission-lines, being gradually deposited and draining to low spots in the pipes, reducing the available area. Some of the moisture will find its way into the ports and exhaust-passages of the machinery using the air, resulting in interference with proper operation by freezing at exhaust-ports as the air expands to atmosphere.

One of the most effective and cheapest methods for the elimination of moisture from pipe-lines is the placing of suitable traps at intervals in the transmission-line, into which the condensed moisture will precipitate and can be conveniently withdrawn. A simple moisture trap, Fig. 4, consists of an enlargement of the air-line. It is provided with baffles and blow-off, the former having holes or slots drilled in the bottom so that moisture can work through to the blow-off pipe. By reason of the pressure always present in the separator the water can be taken from the top. This trap may be made of wrought or cast-iron pipe, with flanged or screwed heads. A good proportion is separator diameter 3 times the air-line diameter and 4 to 6 ft. long. Another effective design is shown in Fig. 5. It consists of a long-sweep tee, three times the diameter of the pipe, with a pocket below to catch the condensed moisture. Both of these separators may be made locally from standard pipe-fittings; also, there are a number of standard-built moisture-traps that may be purchased from various manufacturers. Moisture-traps should be placed at low points in the air-line.

Re-heating the air is a simple process, and serves the double purpose of eliminating annoyance due to freezing as a result of the moisture that the air may contain, and at the same time increasing the air volume.

When the warm compressed air leaves the compressor, and passes through the receiver and the transmission-lines to the point of use, the temperature of the air is considerably reduced. This represents a loss in volume. If the air were used immediately adjacent to the point of production, this loss would not be experienced; but the latter condition seldom, if ever, prevails.

Re-heating the compressed air, at the point where it is to be utilized, a temperature of 250°F., which is usual, results in expanding it in volume from 30 to 35%, at a cost of about $\frac{1}{8}$ of the heat-units required to produce the same volume by compression. This approximation is based on the use of effective form of re-heater, and the use of the air in the cylinder of the engine immediately after passing from the re-heater. In using the re-heater, therefore, it should be placed as closely as possible to the point of use of the air, to prevent loss from radiation of heat after the re-heating process. The re-heater may consist of a cast-iron chamber containing a coil of pipe exposed to a fire, or a current of hot gas or steam. Fig.

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6 shows a cross-section view of one standard type of re-heater, which requires no explanation.

Two tables given in Fig. 7 show the horse-power required for compressing air in single-stage and two-stage compressors at various gauge-pressures. All the conditions of the calculations given are explained in the headings.

Receiver Gauge Pressure Pounds	Diameter of Orifice												
	1/16 inch	1/8 inch	3/16 inch	1/4 inch	5/16 inch	3/8 inch	7/16 inch	1/2 inch	9/16 inch	5/8 inch	1 inch	1 1/4 inch	1 1/2 inch
	Discharge in Cubic Feet of Free Air per Minute												
2	.038	.153	.647	2.435	9.74	21.95	39	61	87.60	119 50	156.	242.	350.
5	.0597	.242	.965	3.86	15.40	34.60	61.60	96 50	133.	189.	247	384.	550.
10	.0842	.342	.136	5.45	21.8	49.	87.	136	196	267.	350.	543.	780.
15	.103	.418	1.67	6 65	26.70	60.	107.	167	240	326.	427.	665.	960.
20	.119	.485	1.93	7.7	30 8	69	123.	193	277	378.	494.	770.	.....
25	.133	.54	2.16	8.6	34 5	77	138.	216	310	422.	550	860.	.....
30	.156	.632	2.52	10	40.	90.	161.	252	362	493	645.	1000.	.....
35	.173	.71	2.80	11.2	44.7	100.	179.	280.	400	550	715.	.....	.....
40	.19	.77	3.07	12.27	49 09	110.45	196 35	306.80	441 79	601.32	785 40	.....	.....
45	208	843	3.36	13.4	53.8	121.	215	336	482	658.	860.	.....	.....
50	225	.914	3.64	14 50	58.2	130	232	364.	522	710.	930.	.....	.....
60	.26	1.05	4.2	16 8	67.	151	268	420	604.	622	.....	.....	.....
70	.295	1.19	4.76	19	76.	171	304	476.	685.	930	.....	.....	.....
80	.33	1.3?	5.32	21.2	85	191	340.	532.	765.	1004.	.....	.....	.....
90	.364	1.47	5 87	23.50	94	211	376	587.	843.	.....	.....	.....	.....
100	.40	1.61	6 45	25 8	103.	231	412.	645	925.	.....	.....	.....	.....
125	.486	1.97	7 85	31.4	125	282	502	785	.....	.....	.....	.....	.....

FIG. 3. DISCHARGE OF AIR FROM ROUND HOLE TO ATMOSPHERE.

Mechanical efficiency of an air-compressor is represented by the ratio of the indicated air horse-power to the indicated steam horse-power in the case of a steam-driven machine, and to the brake horse-power in the case of a power-driven machine. The difference between the two represents excess power required to overcome frictional resistance of the machine, which is largely dependent on the design, workmanship, and supervision received when

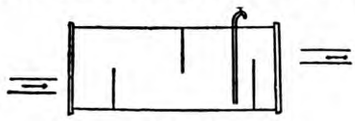

FIG. 4

in operation. Mechanical efficiency of a well-designed compressor ranges between 90 and 95%.

Let us assume a power-driven air-compressor of the

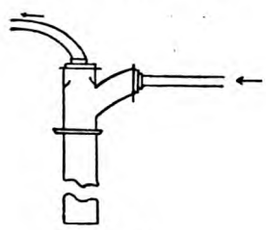

FIG. 5

following size and displacement, and determine its mechanical efficiency:

Diameter of low-pressure cylinder, 16 in.; diameter of high-pressure cylinder, 10 in.; stroke, 14 in.; r.p.m., 165; discharge-pressure, gauge, 100 lb.; piston displacement, cu. ft. per min., 534. From brake-test it was found that the brake horse-power is 93. The air indicator-cards give an indicated horse-power of 83.6. Therefore 83.6 ÷ 93 = 92% mechanical efficiency.

As stated above, loss in mechanical efficiency is determined by frictional resistance. This is a factor that can be largely controlled by the supervising engineer. In general, it is desirable that attention be given to the lubrication system to ensure that all rubbing-parts are sufficiently lubricated at the following points: Bearings,

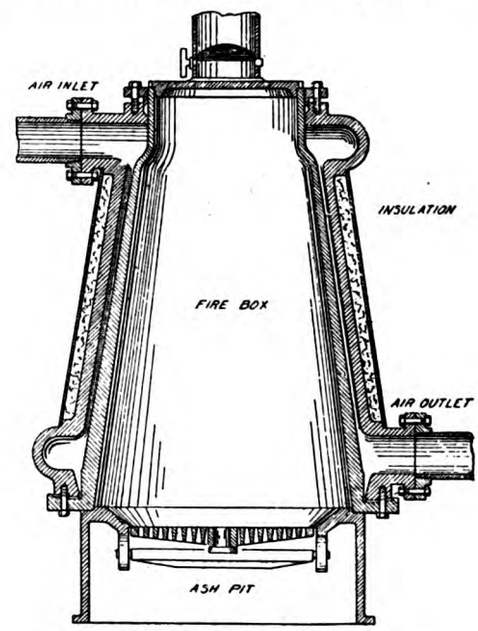

FIG. 6. STANDARD AIR RE-HEATER

cross-heads, stuffing-boxes, and cylinders, as they constitute the chief sources of loss due to friction. Bearings should be drawn up only enough to ensure smooth operation, without undue pressure. Instructions covering the packing of stuffing-boxes have already been given. Cross-head guides must be free enough to permit the cross-head

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to operate without undue pressure, and yet work without knocking.

Different measurements necessary for the calculation of efficiencies are given on the diagrams shown in Fig. 8 and 9. Following are stated the ratios of these measurements resulting in the respective efficiencies and performance measurements of an electrically-driven and a steam-driven compressor.

All compression efficiencies should be subject to correction to perfect inter-cooling, if the specified amount of water at specified temperature is not available.

The theory of compound or stage compression is very

Gauge Pressure Pounds	Absolute Pressure Pounds	Number of Atmospheres	Isothermal Compression		Adiabatic Compression			
			Mean Effective Pressure	H. P	Mean Effective Pressure Theoretical	Mean Eff. Pressure plus 15% Friction	H. P. Theoretical	H. P. plus 15% Friction
5	19.7	1.34	4.13	0.018	4.46	5.12	0.019	0.022
10	24.7	1.68	7.57	0.033	8.21	9.44	0.036	0.041
15	29.7	2.02	11.02	0.048	11.46	13.17	0.050	0.057
20	34.7	2.36	12.62	0.055	14.30	16.44	0.062	0.071
25	39.7	2.70	14.68	0.064	16.94	19.47	0.074	0.085
30	44.7	3.04	16.30	0.071	19.32	22.21	0.084	0.096
35	49.7	3.38	17.90	0.078	21.50	24.72	0.094	0.108
40	54.7	3.72	19.28	0.084	23.53	27.05	0.103	0.118
45	59.7	4.06	20.65	0.090	25.40	29.21	0.111	0.127
50	64.7	4.40	21.80	0.095	27.23	31.31	0.119	0.136
55	69.7	4.74	22.95	0.100	28.90	33.23	0.126	0.145
60	74.7	5.08	23.90	0.104	30.53	35.10	0.133	0.153
65	79.7	5.42	24.80	0.108	32.10	36.91	0.140	0.161
70	84.7	5.76	25.70	0.112	33.57	38.59	0.146	0.168
75	89.7	6.10	26.62	0.116	35.00	40.25	0.153	0.175
80	94.7	6.44	27.52	0.120	36.36	41.80	0.159	0.182
85	99.7	6.78	28.21	0.123	37.63	43.27	0.164	0.189
90	104.7	7.12	28.93	0.126	38.89	44.71	0.169	0.195
95	109.7	7.46	29.60	0.129	40.11	46.12	0.175	0.201
100	114.7	7.80	30.30	0.132	41.28	47.46	0.180	0.207
110	124.7	8.48	31.42	0.137	43.56	50.09	0.190	0.218
120	134.7	9.16	32.60	0.142	45.69	52.53	0.199	0.229
130	144.7	9.84	33.75	0.147	47.72	54.87	0.208	0.239
140	154.7	10.52	34.67	0.151	49.64	57.08	0.216	0.249
150	164.7	11.20	35.59	0.155	51.47	59.18	0.224	0.258
160	174.7	11.88	36.30	0.158	53.70	61.80	0.234	0.269
170	184.7	12.56	37.20	0.162	55.60	64.00	0.242	0.278
180	194.7	13.24	38.10	0.166	57.20	65.80	0.249	0.286
190	204.7	13.92	38.80	0.169	58.80	67.70	0.256	0.294
200	214.7	14.60	39.50	0.172	60.40	69.50	0.263	0.303

FIG. 7. SINGLE-STAGE COMPRESSION

Gauge Pressure Pounds	Absolute Pressure Pounds	No. of Atmospheres	Correct Ratio of Cylinder Volumes	Inter-cooler Gauge Pressure	Isothermal Compression		Adiabatic Compression				Percentage of Saving over One-stage Comp.
					Mean Eff. Pressure	H. P.	Mean Eff. Pressure Theoretical	Mean Eff. Pressure plus 15% Friction	H. P. Theoretical	H. P. plus 15% Friction	
50	64.7	4.40	2.10	16.2	21.80	0.095	24.30	27.90	0.106	0.123	10.9
60	74.7	5.08	2.25	18.4	23.90	0.104	27.20	31.30	0.118	0.136	11.3
70	84.7	5.76	2.40	20.6	25.70	0.112	29.31	33.71	0.128	0.147	12.3
80	94.7	6.44	2.54	22.7	27.52	0.120	31.44	36.15	0.137	0.158	13.8
90	104.7	7.12	2.67	24.5	28.93	0.126	33.37	38.36	0.145	0.167	14.2
100	114.7	7.80	2.79	26.3	30.30	0.132	35.20	40.48	0.153	0.176	15.0
110	124.7	8.48	2.91	28.1	31.42	0.137	36.82	42.34	0.161	0.185	15.4
120	134.7	9.16	3.03	29.8	32.60	0.142	38.44	44.20	0.168	0.193	15.6
130	144.7	9.84	3.14	31.5	33.75	0.147	39.86	45.83	0.174	0.200	16.3
140	154.7	10.52	3.24	32.9	34.67	0.151	41.28	47.47	0.180	0.207	16.7
150	164.7	11.20	3.35	34.5	35.59	0.155	42.60	48.99	0.186	0.214	16.9
160	174.7	11.88	3.45	36.1	36.30	0.158	43.82	50.39	0.191	0.219	18.4
170	184.7	12.56	3.54	37.3	37.20	0.162	44.93	51.66	0.196	0.225	19.0
180	194.7	13.24	3.64	38.8	38.10	0.166	46.05	52.95	0.201	0.231	19.3
190	204.7	13.92	3.73	40.1	38.80	0.169	47.16	54.22	0.206	0.236	19.5
200	214.7	14.60	3.82	41.4	39.50	0.172	48.18	55.39	0.210	0.241	20.1
210	224.7	15.28	3.91	42.8	40.10	0.174	49.35	56.70	0.216	0.247	
220	234.7	15.96	3.99	44.0	40.70	0.177	50.30	57.70	0.220	0.252	
230	244.7	16.64	4.08	45.3	41.30	0.180	51.30	59.10	0.224	0.257	
240	254.7	17.32	4.17	46.6	41.90	0.183	52.25	60.10	0.228	0.262	
250	264.7	18.00	4.24	47.6	42.70	0.186	52.84	60.76	0.230	0.264	
260	274.7	18.68	4.32	48.8	43.00	0.188	53.85	62.05	0.235	0.270	
270	284.7	19.36	4.40	50.0	43.50	0.190	54.60	62.90	0.238	0.274	
280	294.7	20.04	4.48	51.1	44.00	0.192	55.50	63.85	0.242	0.278	
290	304.7	20.72	4.55	52.2	44.50	0.194	56.20	64.75	0.246	0.282	
300	314.7	21.40	4.63	53.4	45.30	0.197	56.70	65.20	0.247	0.283	
350	361.7	24.80	4.98	58.5	47.30	0.206	60.15	69.16	0.262	0.301	
400	414.7	28.20	5.31	63.3	49.20	0.214	63.19	72.65	0.276	0.317	
450	464.7	31.60	5.61	67.8	51.20	0.223	65.93	75.81	0.287	0.329	
500	514.7	35.01	5.91	72.1	52.70	0.229	68.46	78.72	0.298	0.342	

FIG. 7. TWO-STAGE COMPRESSION

readily understood. It is generally conceded that compound or stage compression should be employed (*a*) with small capacity machines when pressures range over 125 lb., (*b*) with large capacity machines when pressures range above 70 lb. The heat of compression increases with the pressure, therefore, the higher the pressure, the more difficult it is to reduce the temperature of the air to a point where efficient compression conditions and proper air-cylinder lubrication obtain. For instance, in compressing air to 100 lb. terminal gauge-pressure in a single cylinder, the final temperature would be about 485°F. Some of this heat would be absorbed by the cylinder-walls and water-jackets, but the final temperature would remain too high to ensure efficient compression conditions and proper lubrication.

For Electrically-Driven Compressors

$\frac{\text{B.hp.}}{\text{E.hp.}}$ = motor efficiency.

$\frac{\text{I.hp. air-cylinder}}{\text{B.hp. on shaft}}$ = mechanical efficiency.

$\frac{\text{Free air actually delivered}}{\text{Piston displacement}}$ = actual volumetric efficiency.

$\frac{\text{Length l.p. intake-line}}{\text{Length indicates diagram}}$ = indicated volumetric efficiency.

$\frac{\text{Actual volumetric efficiency}}{\text{Indicated volumetric efficiency}}$ = slippage efficiency.

$\frac{\text{I.hp. air-cylinder} \times 100}{\text{Cu. ft. actually delivered per min.}}$ = I.hp. per 100 cu. ft. delivered per min.

$\frac{\text{E.hp. input at switchboard} \times 100}{\text{Cu. ft. actually delivered per min.}}$ = E.hp. per 100 cu. ft. delivered per min.

$\frac{\text{Isothermal factor}}{\text{I.hp. per 100 cu. ft. delivered per min.}}$ = isothermal compression efficiency.

$\frac{\text{Isothermal factor}}{\text{E.hp. per cu. ft. delivered per min.}}$ = overall isothermal compression efficiency.

For Steam-Driven Compressors

$\frac{\text{I.hp. air-cylinders}}{\text{I.hp. steam-cylinders}}$ = mechanical efficiency.

$\frac{\text{Free air actually delivered}}{\text{Piston displacement}}$ = actual volumetric efficiency.

$\frac{\text{Length l.p. intake-line}}{\text{Length indicates dagram}}$ = indicated volumetric efficiency

$\frac{\text{Actual volumetric efficiency}}{\text{Indicated-volumetric efficiency}}$ = air i.hp. per 100 cu. ft. delivered per min.

$\frac{\text{Isothermal factor}}{\text{Air i.hp. per 100 cu. ft. delivered per min.}}$ = isothermal compression efficiency.

$\frac{\text{Isothermal factor}}{\text{I.hp. steam-cylinder per 100 cu. ft. per min.}}$ = overall isothermal compression efficiency.

$\frac{\text{Pounds steam per hour}}{\text{I.hp. steam-cylinder}}$ = steam consumption per i.hp. hour.

$\frac{\text{Pounds steam per min.} \times 1000}{\text{Cu. ft. free air delivered per min.}}$ = lb. steam per 1000 cu. ft. air delivered.

In Fig. 10 is shown a theoretical combined indicator-diagram from a two-stage compressor. It is assumed that the compression follows the adiabatic curve in both cylinders, with perfect inter-cooling between. AB = volume of low-pressure cylinder; CD = volume of high-pressure cylinder, both drawn to the same scale. ACF = pressure to some designated scale; BEK (adiabatic curve) = relation between pressure and volume for any piston position, with no inter-cooling and no radiation through the cylinder-walls. In this curve the product $PV^{1.41}$ is constant (1.41 is the ratio between the specific heat of air at constant pressure and constant volume), where P = pressure and V = volume. BDH (isothermal curve) = relation between pressure and volume, provided the temperature of the air under compression could be kept constant so that the product PV would also be constant. Air taken into the low-pressure cylinder at zero gauge-pressure, is compressed along the adiabatic curve BE until at E it attains a pressure of 26.3 lb., equal to that of the inter-cooler, allowing the discharge-valves to open and the air to pass into the cooler. In the inter-cooler, the volume of a definite weight of the air is reduced from CE to CD, so that the volume entering the high-pressure cylinder is less to the

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extent of *DE*, which is the same scale as *CD* and *AB*. This means that the given weight of air represented by the volume *CE* at a gauge-pressure of 26.3 lb., when cooled to the same temperature at which it was originally taken into the low-pressure air-cylinder, will be reduced in volume to *CD* provided the pressure of 26.3 lb. remains constant.

Air taken into the high-pressure air-cylinder at 26.3

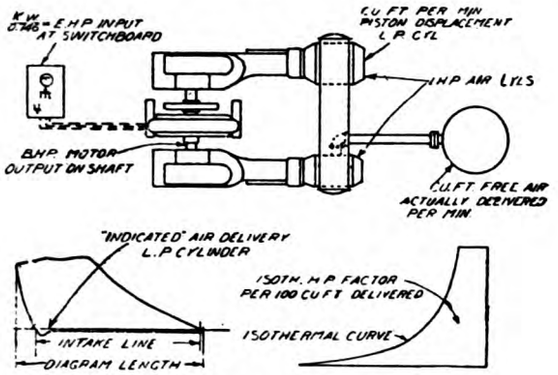

FIG. 8. ELECTRICALLY-DRIVEN COMPRESSOR

lb. is compressed along the adiabatic curve *DG*. At *G* the high-pressure discharge valves open and the air is discharged into the receiver at the desired gauge-pressure of 100 lb. The shaded portion represents the power saving effected by the inter-cooler.

The saving due to the reduction in temperature be-

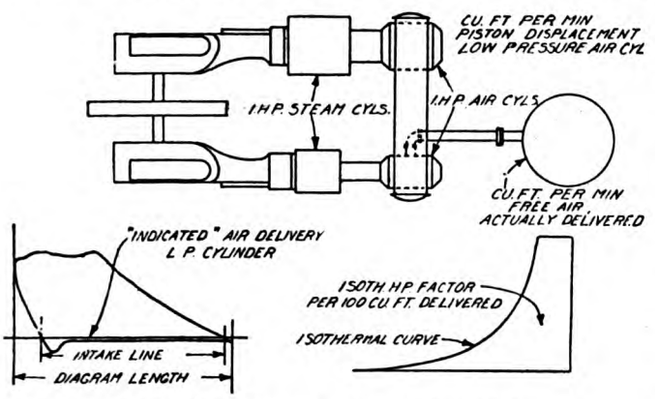

FIG. 9. STEAM-DRIVEN COMPRESSOR

tween stages is not the only advantage of stage compression. The maximum temperature in each cylinder is reduced to a point where the heat can be more thoroughly drawn off by the water-jackets surrounding the cylinder walls; also, the lower temperature in the cylinder is an insurance of good lubrication of piston and valves.

As already indicated, the theoretical function of the inter-cooler in stage compression is to reduce the temperature of the air after it leaves the low-pressure cylinder to the same point at which it was first taken into that cylinder, before it enters the next stage cylinder. Under practical working conditions, however, it will be found that the majority of coolers fail to accomplish this result, and a reduction to within 5 to 10° of the original temperature is considered a good accomplishment.

The inter-cooler consists of a shell containing a nest of tubes arranged in a series of groups through which water flows successively, entering the bottom row and finding an outlet through the top row. Surrounding the water-tubes is a series of baffle-plates, which direct the flow of the air so as to split it up into thin films and ensure intimate contact with the cold water-tube surfaces. By reducing the spacing of these baffles as the high-pressure cylinder is approached, the most efficient velocity of air in transit is attained. When the air comes in contact with the cold-tube surfaces, condensation of the moisture occurs, and it drips and flows down into the bottom of the

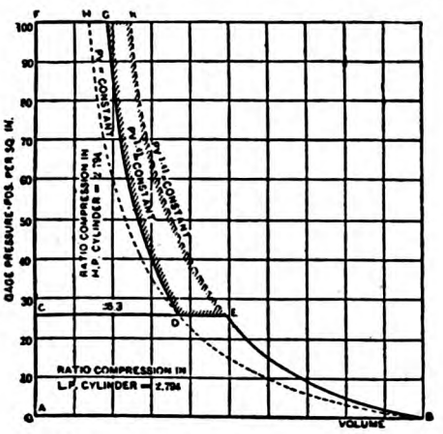

FIG. 10. COMBINED DIAGRAM

shell. In order to drain this condensed water the inter-cooler is usually placed at an incline, so that the water will flow into the pocket surrounding the water separator where a drain-cock is provided for the occasional removal of the water. Temperature changes in the inter-cooler cause the tubes to expand and contract, and in order to provide for this it is customary for the best of tubes to be fixed at one end only, while the other end, including the water-box, is left free to move with the tube-plate.

As for any other piece of machinery, the load-factor of an air-compressor is the average amount of work actually done, divided by the maximum capacity for work. The result represents the commercial efficiency of the machine, or in other words, the overall cost of production.

It is usual to install an air-compressor to take care of the maximum demand and depend upon some automatic means of regulation or unloading to vary the output of the machine to fluctuating needs. This varies the horse-power input with the load, and effects a saving in cost of operation. It is further usual where the load will vary materially, especially in electrically-driven plants of large capacity, to put in a number of small units and vary the number operating, keeping them at full load to comply with changes of load, to assist in maintaining the highest overall economy. In such cases, regulation depends upon automatic starting and stopping.

The reduction in horse-power input with power-driven air-compressors controlled by some form of part unloading device is not in direct ratio to the reduction in output. For instance, in Fig. 11 is shown a series of cards taken from 28 to 17½ by 21-in. electrically-driven

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two-stage air-compressor, operating at 185 r.p.m., and equipped with a four-step clearance regulator. It will be noted that at three-quarter load capacity, the horsepower input is 77.5%; at half-load, 55%; at quarter-load, 30%; and at no load 3.6%. The difference is accounted for by the fact that the mechanical efficiency drops off rapidly with a decrease in load; for example, in this particular case at full load the efficiency is 94%;

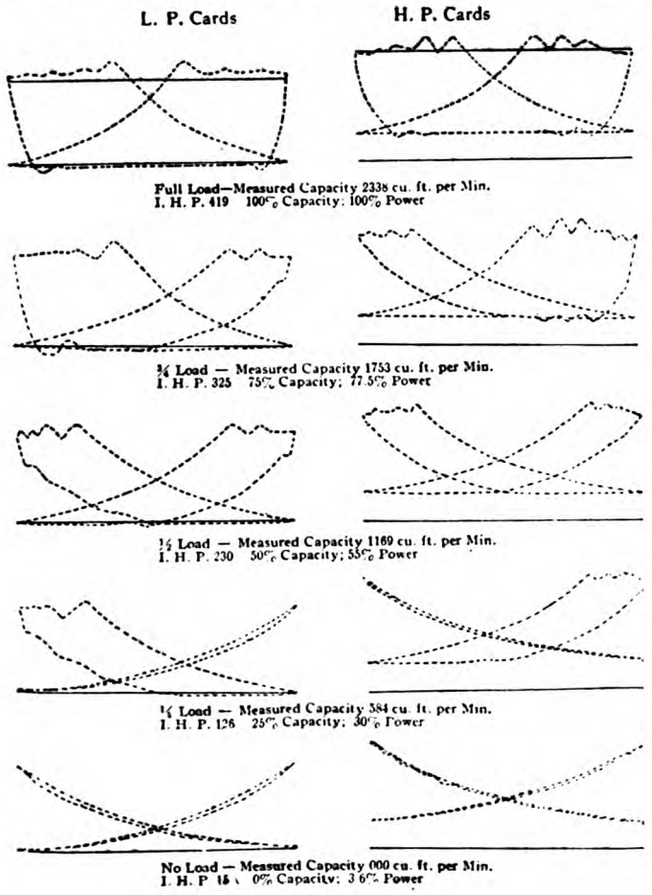

FIG. 11

three-quarter load, 92%; half-load, 87.5%; and at quarter-load, 80%.

Air-compressor control-devices are usually set by the manufacturer to meet the conditions imposed by the particular installation, and as the design of these devices varies with the different manufacturers, instructions of only a general nature can be given here. If the device fails to function properly, it is probably due to an obstruction in the way of dirt or other foreign substance, and not to a need for readjustment. It should be thoroughly cleaned and care taken in re-assembling to adhere to the adjustment existing prior to the overhaul.

JUDGE: "Why did you strike this man?"

Prisoner: "What would you do, judge, if you kept a grocery-store and a man came in and asked if he could take a moving picture of your cheese?"—'The Yellow Strand'.

California Industrial Accidents

A report on special investigations of permanent injuries, composed largely of a survey of 700 cases where injury is so serious in character as to constitute at least an industrial and economic handicap, has been issued by the Industrial Accident Commission of California. Nearly all these cases are of sufficient duration for time and therapeutical efforts to have made whatever readjustments may be expected. At this time there is, therefore, chance to form a fair judgment of final consequences of the injuries. The findings are not the mere refinements of statistics gathered from reports; the facts included are not local; they are not gathered from a single community, from a particular line of industries, of a special class of workmen. They came from various communities in different parts of the State, and include almost every form of industry from street sweeping to banking. They were obtained at first hand by experienced investigators from the living sources themselves. The investigators met the injured in their homes, their places of employment, or in the offices of the Commission.

The percentage of injuries in the entire 700 cases were as follows: head and face, 4½; eye, 21; arm and hand, 36½; leg and foot, 23; trunk—including spine, 5½; and multiple injuries, 7.

In a classification by age, at the time of injury, there were 28 under 20, 580 over 20 but under 56, and 88 over 56 years.

In a classification by attitude toward injury and general outlook on life the following was found:

	Attitude	Outlook
Cheerful	503	..
Indifferent	75	..
Discouraged	122	..
Optimistic	...	19
Normal	...	606
Pessimistic	...	75

The general averages of all the classifications are:

Whole number under survey	700
Age at time of injury, years	37.8
Wage, before injury, weekly	$22.34
Wage, since injury, weekly	16.60
Disability rating, weeks	139
Compensation, weekly	$13.55
Time lost on account of injury, months	11.95
Number of dependents	2
Average age of children, years	9.5

While general averages often do not convey very definite and helpful information, there is still something about them that makes one wish to find what they are. This table will help very materially in forming a general conception of the conditions that obtain through permanent injury.

WELLESLEY was bewailing the lack of romance in the average girl of today.

"It's sickening," he growled. "A feller can pour out his soul all the blessed night on a violin and she won't trouble to look out of the window. But give three toots on a motor horn any afternoon and she's outside in a jiffy."

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Electric-Arc Welding*

By C. D. FAWCETT

AT present portable welding-units are commercially available giving adequate power for one or two operators. Stationary units especially designed for welding may be obtained for any number of operators. Direct current is favored and has many advantages over alternating current. Research work is being done on alternating-current outfits, but they have not yet reached the state of perfection of the direct-current units—alternating current being inherently opposed to easy manipulation by the operator. The alternating-current units on the market and under development combine some sort of variable reactance in the circuit which produces a phase displacement of voltage and current tending to steady the arc. Some recent tests of these units give reason to hope that alternating current will become commercially practical for welding.

The ideal arc would be held at a constant distance from the work, say 3/32 in., and would operate at constant-arc voltage and constant current. No operator, however, consistently holds the ideal arc. Designers and manufacturers attempt to fill the gap by providing units that have characteristics calculated to minimize the human element. As a result we have the constant-energy unit, which gives constant arc-power-consumption under variations in arc-length, and the constant-current unit, which maintains an unvarying current under different arc-lengths. The operator should feed the electrode into the work at a rate that will maintain a uniform arc-length between the electrode-tip and the centre of the crater formed on the work by the arc. The rate of consumption of the electrode depends upon the current through the arc. The arc-length, therefore, is affected by the muscular movements of the operator and by the consumption of the electrode.

The direct-current units used for welding are of two general types: the external-resistance control, and the inherent or self-regulating control. The resistance-type employs variable grid resistances connected in series with the line and the arc. A variation of this type consists in carbon-piles automatically controlled by solenoids operated by the welding current.

Sets having inherent regulation are preferable from the standpoint of efficient operation. The average efficiency of these units under normal operating conditions, taken as the ratio of arc-energy to the total input to the set, is 55%, while the efficiency of the grid-resistance units is 25%. On the other hand, the internal-control units consume power in running idle, while the grid-resistance type takes energy only during the welding process. An efficient operator will hold the arc approximately 65% of the working time, the remaining time being consumed in changing electrodes, resting, etc. It is assumed that the preparation of the work to be welded is not done by the operator, although it should be done under his direction.

It is necessary to review some of the principles connected with metallic-electrode arc-welding before forming an opinion of the kind of apparatus required and the training that a welder should have.

The length of the arc between the molten globule of metal on the tip of the electrode and the centre of the crater on the surface being welded is held at approximately 3/32 in. by an expert operator.

The magnetic field is set up by the current through the arc. The flux-density and shape of this field is dependent upon the shape and permeability of the metal worked upon. As the welding proceeds along the seam or in the corners of the work, the magnetic field is likely to be distorted or changed in density, with the result that a blow-out effect is produced which may either help or hinder the operator. As a general rule the effect is helpful if the arc is blown in the direction of welding, but if the field is too strong it may be difficult to hold the arc.

There is a chimney effect from the hot air and gases rising from the heat of the arc. This moving column of air may come through the seam being welded or rush in from the surface of the plate after the seam is closed. In many cases the arc is blown in one direction or another by these drafts. Air-currents from open doors or windows are detrimental in the same way. The effects of these natural draft and magnetic blow-out phenomena may often be confused.

A thin vapor envelope of gases surrounds the arc-stream and produces a steadying effect upon the arc, resisting the effects of natural drafts and magnetic field and confining the heat energy to the arc-stream. This envelope becomes dense around the arc from covered electrodes and extends down upon the surface of the deposited metal where it is condensed and forms slag. Two grades of covered electrodes are used; one grade producing a gaseous envelope, the other a liquid-flux envelope. It is easier to hold a steady arc if covered electrodes are used, but the weld is more likely to contain slag.

Gravity acting upon the dense arc-vapor and the molten metal tends to confine the arc to the centre of the crater on flat work, but is detrimental to the operator on overhead work. Hot metal flowing against cold

*Abstract from University of Colorado 'Journal of Engineering'.

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surfaces is chilled by the contact and prevents the welding. It is therefore important that the arc should play upon the work in such a way that the surfaces adjacent to hot metal shall always be pre-heated to a welding temperature.

Surface-tension draws the liquid metal into the sides of the crater formed under the arc. This phenomenon is easily seen through the screen. The experienced welder learns to watch this drawing-in and by a proper use of the arc he is able to add metal at a rate that will allow the combined forces of surface-tension, contraction, and gravity to form a flush weld or a reinforced weld as desired.

Because of the high temperature close to the crater, the density of the air surrounding it is much less than normal. As a result the cooler and denser air exerts a pressure inward toward the crater. This is closely related to the chimney effect mentioned previously. The pressure, however, is localized so close to the centre of the crater that its action upon the arc-stream is to force it always toward the centre, opposing the action of unfavorable drafts and magnetic fields. This is one of the forces that materially assist the operator in overhead welding.

The pinch effect, or the phenomenon tending to pinch together the central portion of a molten-metal conductor, acts upon the hot metal on the end of the electrode and hastens the entrance of the globule into the arc-stream. These drops of metal are vaporized immediately upon entering the arc-stream. When the current is too low, a drop of the molten metal may pass through the arc without vaporizing, often extinguishing it.

The chemical composition and uniformity of the metal in the electrode controls the rate of fusion under given electrical conditions. When impurities or foreign elements are fed into the arc at the tip of the electrode, the operator finds it hard to do uniform work.

The contraction of the welded metal causes the surfaces of the finished work to have a contour different from what the appearance of the molten metal under the screen would indicate. The welder must judge the contraction in order to secure the desired fill and finish.

The physical phenomena already mentioned are of no greater importance to good welding than are the mental and physical characteristics of the welder. A skilled operator must be conscientious. He is the sole judge of the excellence of his work. He alone can know when the arc is biting-in. If it fails to do so, he must manipulate the arc so as to correct the failure, and this must be done before the edges of the crater adjacent to the fault are allowed to fall below the welding temperature.

The craftsman must have fine muscular control of his arm and body. His job is to guide the tip of a steel rod continuously and uniformly at distances varying from 20 to 5 in. from his hand, and this control must have a lateral movement judged to a variation of not over $\frac{1}{16}$ in., and a uniform feed into the arc. This is a free-arm motion from the shoulder. The arc-welder may be said to be painting with pigments of molten steel. Good eyesight and acute hearing are absolutely necessary to the welder. The appearance of the metal and the arc, as seen through the shield, enables the operator to study the effects previously described and to make the best possible use of the forces of nature to assist him at his work. The sound of the perfect short-arc is broken only by an imperfect note from an arc needing adjustment.

The current used should be as high as the operator can control; but should not be great enough to burn the metal, nor leave too much molten metal in the crater. A current of from 60 to 100 amperes may be used on $\frac{1}{8}$ to $\frac{1}{4}$-in. plate, and this may be increased to 200 amperes on inch plate. The voltage across the arc will vary from 16 to 30. The size of the crater should be such that a circular area of molten metal, having a diameter of about $\frac{5}{8}$ in., surrounds the arc. The diameter of this crater should always be large enough to ensure that the metal deposited will condense on the molten metal of the work. The play, or movement of the arc, is important in producing this local pre-heating.

The electrode-holder should clamp the welding-wire firmly, at the same time providing easy means of inserting new wire and of removing the short ends. The handle should be well insulated from the heat transmitted to it by the electrode. Handles with swivel connections to the cable from the welding-unit should frequently be disassembled and cleaned, because the oxide deposited from the arc-vapors coats these surfaces and increases the resistance to the current, causing local heating within the handle. A heavy-wire brush, chisels, a ball-peen hammer, and a chipping hammer complete the list of tools needed by the welder. The latter tools are for cleaning the surfaces of the work. It is especially important to remove the slag and oxide from the successive layers of the deposited metal. A homogeneous connection cannot be made without these cleaning operations.

The eyes should be protected from infra-red and ultra-violet rays of the arc by a shield providing high visibility without glare. A dense ruby glass covered by an emerald green, with a clear glass on the arc side of the shield, should form the window through which the operator views his work. The clear glass should be replaced frequently as it becomes pitted and obscures the view. The density of the glasses should be suited to the needs of the individual operator. In all cases the arc stream and the crater under the arc should be clearly visible. The shield should protect the entire face and neck from the direct and reflected rays of the arc.

The hands should be protected by heavy gloves and gauntlets; a combination of thin leather lined with heavy cotton gives the best protection from the heat. A light leather apron extending from the shoulders to the knees affords protection to the shoulders, although many operators object to using it. On overhead work the leather apron or an asbestos mat over the shoulders and knees is desirable in order to avoid serious burns.

The surfaces to be welded must be arranged in the proper relation and clamped or tacked together by the

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arc. If the joint is to be made between long seams an allowance must be made for expansion. The usual allowance is a separation of $\frac{1}{8}$ in. per foot; that is, a seam 4 ft. long would be clamped $\frac{1}{2}$ in. wider at one end than at the other. The operator would then start at the narrow end and weld toward the wide end, expecting the seam to close to a uniform width as the work progressed. In some commercial work the seam is tacked at a uniform separation over the full length and the operator welds short lengths of the seam at various points chosen to give equal expansion throughout the work, until the seam is completely closed.

The edges of plates over $\frac{1}{8}$ in. thick should be beveled before butt-welding. The beveled edges of plates to be butt-welded by the arc should be separated $\frac{1}{8}$ in. plus the allowance for expansion. Table I gives data on electrode-diameter, plate-thickness, current in the arc, and plate-bevel. The number of layers of metal required to join a given thickness of plate depends upon thickness, bevel, and separation of the plates, and upon the current density in the arc. In general, a layer of metal $\frac{1}{8}$ to $\frac{3}{16}$ in. deep may be successfully deposited.

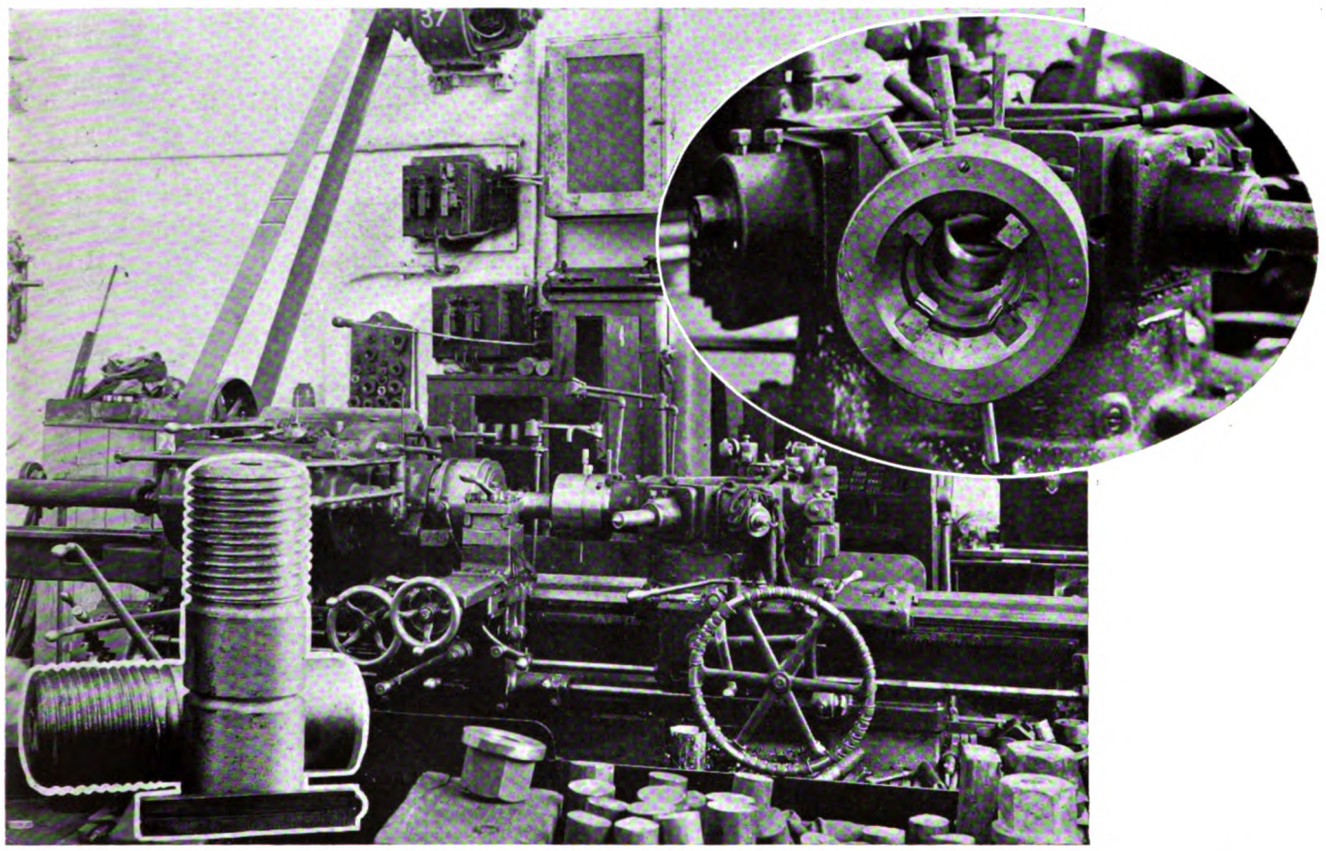
Table I

Electrode-diameter, inches	Plate-thickness, inches	Arc-current, amperes	Bevel of plate edge, degrees
1/8	⅛ to ¼	60 to 100	0 to 30
5/32	⅜ to ½	100 to 140	30
5/32	⅝ to ¾	140 to 170	45
3/16	¾ to 1	170 to 200	45

Threading Large Studs by the Use of an Adjustable Die-Head

The largest automatic-opening adjustable die-head in use in the San Francisco Bay district is in operation at the Second Street shops of the Moore Shipbuilding Co. If material economies in shipbuilding are to be attained, permitting lower cost per ton, labor-saving equipment such as this machine is necessary.

The largest studs on a ship of the ordinary designs are in the propeller-hub holding the blades. In this instance the studs are $3\frac{1}{2}$ in. diam, United States Standard, and there are 32 in each hub. It is a laborious task to 'chase' these threads in the good old-fashioned way, and it requires a great deal of time. A 'wise-owl foreman', who said little but thought much, wondered why he could not make large studs as well as small ones in the Geometric way; his faith and judgment being equally strong he installed the Geometric die-head shown in the illustration. The experiment proved a complete success, reducing the actual threading-time per stud from 14 to 4 minutes. Furthermore, the micrometer-adjustment feature rendered it feasible to make the studs an exact fit to the tapped holes.



GEOMETRIC DIE-HEAD. ABOVE IS A NEARER VIEW, AND THE STUDS MADE ARE SHOWN IN THE LOWER CORNER

We are indebted to W. M. McGee, the foreman in this shop, for the information and illustrations for this article. Progressive methods such as these reflect credit upon the management.

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The Work of the American Engineering Standards Committee*

IN many lines of engineering, much excellent standardization work had been done before the War. The War emphasized its importance and showed most clearly the need of co-operation to prevent the confusion caused by the promulgation of overlapping standards by independent bodies. During the War the Government departments co-ordinated these efforts in certain lines and assisted greatly in unifying them. The American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, and American Society for Testing Materials, recognizing the value of what had been done, invited the Departments of War, Navy, and Commerce to appoint representatives to act with them to continue this work. The body so formed is the American Engineering Standards Committee. It has required considerable time definitely to formulate its objects, and to arrange methods for accomplishing them that would be effective without in any way interfering with the many organizations that have been doing such excellent work in this line.

The American Engineering Standards Committee was founded to meet war needs, but has been continued because its activities are no less important in time of peace.

The American Engineering Standards Committee has just completed and adopted a revision of its constitution, which has been sent to the governing boards of all the departments and societies represented on the Committee with a request for its ratification. The new constitution changes the name to 'American Engineering Standards Association', the change from 'Committee' to 'Association' more fittingly indicating the wide scope of the interests involved.

The objects of the Association are stated as follows:

1. To unify and simplify the methods of arriving at engineering standards, to secure co-operation between various organizations, and to prevent duplication of standardization work;

2. To promulgate rules for the development and adoption of standards;

3. To revise and pass upon recommendations for standards submitted as provided in the rules of procedure, but not to initiate, define, or develop the details of any particular standard;

4. To act as a means of inter-communication between organizations and individuals interested in the problems of standardization;

5. To give an international status to approved American engineering standards;

6. To co-operate with similar organizations in other countries and to promote international standardization.

Means are provided for increasing the number of representatives in the Association by invitation or on request. Several important organizations interested in standardization will be invited to appoint representatives as soon as the necessary authorization is obtained.

Means are provided for increasing the number of representatives in the Association.

The routine work of the Association will be conducted by its secretary under the direction of a Board of Directors. This Board will have power to deal with all of the affairs of the Association except the final approval of the standards submitted to it.

Any organization may request the Association to approve standards that it has formulated, or to approve committees that it has appointed, and by so doing becomes a 'Sponsor Society'. Such a request is entirely at the option of the organization that has formulated or expects to formulate the standard. At the request of the Sponsor, approval of the standards is given when they are the substantially unanimous conclusions of a committee made up as follows:

1. Sectional committees dealing with standards of a commercial character (specifications, shop practices, etc.), shall be made up of representatives of producers, consumers, and general interests, no one of these interests to form a majority. A producer is a person, or the representative of a firm or corporation, directly concerned in the production of the commodity involved. A consumer is a person, or the representative of a firm or corporation, that uses the commodity involved, but is not directly concerned with its production. General interests include independent engineers, educators, and persons who are neither consumers nor producers, as defined above.

Committees to formulate standards will be composed of representatives of producers, consumers, and the general public.

2. Sectional committees dealing with standards of a scientific or non-commercial character shall consist of persons specially qualified, without regard to their affiliations.

It is anticipated that in nearly all cases the approval of standards and committees by the Association will be requested. If it is considered advisable, the Association is authorized to call a meeting of those who would be

*Statement authorized by the Committee.

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interested in the formulation of a new standard or the revision of an old one in order to select one or more Sponsor Societies. The Sponsor Society or Societies will appoint a sectional committee to formulate or revise the standard. This sectional committee will report to the Sponsor when its work is completed. The Sponsor may then request the Association to approve. The Association deals only with the Sponsor and acts only at its request. Provision is made in all publications that a standard must be referred to as that of the Sponsor, using whatever title the Sponsor has given it, followed by the statement 'approved by the American Engineering Standards Association'. The approval may be given in one of three ways as—recommended practice, tentative standard, or standard, the expectation being that nothing will be approved as standard until it has been shown to be generally acceptable.

The Association thus acts only to bring together those interested in a common object, and when they have completed their work, will at their request, certify that it has been done in such a manner as to justify its adoption. Nothing revolutionary is proposed, it is merely an extension of present practice. The Executive Committee of the American Society for Testing Materials now passes on the composition of committees, ascertains that their conclusions are substantially unanimous, and if so, reports them to the society for acceptance or rejection. The Association does the same for groups of organizations. Its Board of Directors performs the same functions as the Executive Committee of the American Society for Testing Materials, and the Association as a whole accepts or rejects. It neither selects Sponsors nor Sectional Committees; it does not consider the subject matter of a standard, nor the procedure under which it has been determined, except that it requires sufficient information from the Sponsor to show that the conclusions are substantially unanimous and that the Sectional Committee is balanced and representative. It requires that in all publications the Sponsor shall be given full credit.

In addition to assisting in the selection of committees and certifying that their work has been done under proper condition, the Association will act as a bureau of information regarding standardization. It will collect information regarding existing standards and as to the bodies that have formulated and adopted them. This will enable it to give promptly necessary information to those who select a committee to formulate a new standard or revise an old one. It will also enable it to furnish information desired by the working committees regarding what has been or is being done on similar or related lines. It will establish relations with similar bodies in other countries and can do much to promote the acceptance of international standards. It is possible to secure international acceptance of American standards more easily through such a body than in any other way.

In addition to assisting in the selection of committees and certifying that their work has been done under proper conditions, the Association will act as a bureau of information regarding standardization.

With these fundamental restrictions of its activities it may be asked whether there is sufficient reason for the existence of the Association. This naturally has been considered carefully and it is the unanimous conclusion of the committee and of all of those who have been consulted and who have been active in standardization work, that such an organization is urgently needed. In the past there have been many occasions when two or more organizations have formulated standards for substantially the same thing. Often these differences have been slight, but neither standard has been quite acceptable to the other organization. In the majority of such cases, if these organizations had been brought together at the start, they could have agreed on a standard that would have been satisfactory to both. The American Engineering Standards Association will furnish a means by which any organization intending to define a standard can readily ascertain what other organizations are interested, and what organizations should be consulted in regard to it. At present there is no such means. There is nowhere anything approaching a complete list of the organizations doing standardization work, much less any list of the standards proposed or in preparation. The enormous advantage of having any standard generally accepted, and the much greater probability of accomplishing this if it is prepared under definite conditions that have proved effective in the past, will, it is believed, cause most of the organizations engaged in such work to ask and receive the assistance of the American Engineering Standards Association. It provides definite machinery for securing co-operation and preventing duplication of work. It establishes definite rules securing the absolute autonomy of any group engaged in the development of standards and ensures that this group shall receive full credit for its work.

The American Engineering Standards Association will furnish a means by which any organization intending to define a standard can readily ascertain what other organizations are interested and what organizations should be consulted in regard to it.

With the assurances of co-operation already received by the American Engineering Standards Association there is no question of the advisability of forming the more broadly representative Association. Several organizations have already presented requests for the approval of existing standards and many others only await the notification of the Association that it is fully organized.

The headquarters of the Association are in the Engineering Societies building, 29 West 39th street, New York. The acting secretary is Clifford B. LePage.

SAY what you will about the Ten Commandments, you must always come back to the pleasant fact that there are only ten of them.—H. L. Mencken.

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Shop Lighting as a Means of Accident Prevention*

By C. W. PRICE

THE Travelers' Insurance Co. recently analyzed 91,000 accidents that occurred in factories and discovered that 10% were caused directly by poor lighting, and in 13.8% of the accidents poor lighting was a contributary cause. A study of industrial accidents by the British government revealed the fact that 39.5% more men stumble and fall during the winter months than during the summer. This class of accidents, more than any other, it was contended, is due to improper lighting. Companies that, during the past five years, have made the largest reductions in accidents, testify that good light is indispensable to safety. A dark shop is a dangerous shop. The experience of a large number of plants shows that the total cost of furnishing adequate artificial light in an average plant does not exceed ½% of the payroll.

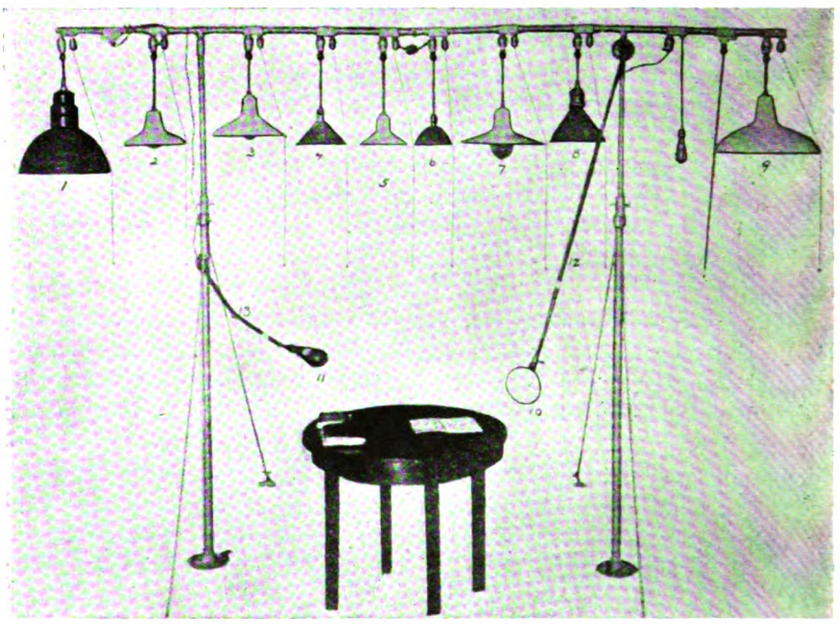
The following standards are based on the experience of such companies as the International Harvester Co., the Pfister & Vogel Leather Co., and the Kimberly-Clark Co. These standards are embodied in the orders of the Industrial Commission of Wisconsin:

In shops where there is no smoke or gas there shall be provided for each four square feet of floor-space, light equivalent to the light produced by a 1-candle-power lamp hung 10 ft. from the floor, or to put it more simply, ¼ candle-power per square foot of floor. A 100-candle-power lamp will light 400 sq. ft. of floor-space. One-eighth candle-power per square foot of floor is required for warehouses. On machines and benches, where close work is done, sufficient light must be provided to prevent eye strain.

Experience has demonstrated that the above standards for general illumination are not only adequate for safety, but in all departments where ordinary work is done, such as paper-mills and woodworking and coarse metal-working shops, these standards provide sufficient light for a fair degree of efficiency and make unnecessary the use of individual machine-lights. When finer work is done ½ to 1 candle-power per square foot of floor is necessary.

*Abstract from Bulletin No. 248, U. S. Bureau of Labor Statistics.

The tungsten lamp is recommended as the most efficient type of lamp for all conditions. The modern tungsten lamp is a great economizer of current. The old type of carbon-filament lamp consumed 54 watts for 16 candle-power, or about 3½ watts per candle-power. The gas-filled tungsten lamp consumes from seven-tenths to one watt per candle-power. One of the leading shoe-factories of Wisconsin recently took out a dray-load of the old type of drop-cords with carbon lamps and installed tungsten lamps with efficient reflectors. The amount of light was increased 400% and the cost of current was decreased 25%. The guaranteed life of the tungsten lamp is 1000 hours. Many plants are getting an average of 1500 hours with the 100-watt units and larger.



DIFFERENT TYPES OF REFLECTORS

A properly designed reflector will increase the efficiency of a lamp 35 to 50%. Of the light from a gas-filled tungsten lamp, 65% proceeds horizontally from the filament. Unless this light is re-directed by a reflector to the working-plane it is wasted on the upper parts of the room. The deep-bowl reflector is recommended for general illumination. It properly concentrates and distributes the light upon the working-plane. These reflectors should be made of white porcelain-enameled steel. This material is durable, inexpensive, and easily cleaned. When reflectors are kept clean the efficiency is increased 25%. The lamp should be so attached in the reflector

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that the centre of the filament is on a plane drawn through the centre of the reflecting surface.

General Illumination of Departments in Which Coarse Work Is Done—Ceilings 12 to 16 ft.

Lamp.—100-watt gas-filled tungsten.

Reflectors.—Deep bowl, 10 in. diam. (No. 8).

Height.—10 ft. to bottom of reflector.

Spacing.—20 ft. centre to centre. Do not arrange regularly over room, but place lamps over machines and benches so far as possible. This arrangement will make unnecessary individual lights in departments where there is no close work.

Amount of light.—Not less than one-fourth candle-power for each square foot of floor-space. A 100-watt lamp will illuminate 400 sq. ft. of floor-space. To secure efficiency, ½ candle-power for each square foot of floor-space is necessary in many departments when the work is at all close.

Warehouses With Low Ceilings and Basements of Mills

Lamp.—Tungsten, 60-watt.

Reflector.—Shallow bowl, 12 in. diam. (No. 2).

Height.—As high as possible.

Spacing—19 ft. centre to centre.

Amount of Light.—⅛ candle-power per square foot of floor.

Stairways

Lamp.—Tunsten, 40-watt.

Reflector.—Cone-shaped (No. 4).

Height.—As high as ceiling will permit.

Position.—At head of stairs.

Platforms

Lamp.—Tungsten, 60-watt.

Reflector.—No. 2 and 7.

Height.—12 ft. from floor.

Spacing.—Over centre if platform is covered. If open, attach to brackets about 4 ft. long, extending from side-walls.

Amount of light.—⅛ candle-power per square foot of floor.

Yards

Lamp—Tungsten, 300-watt.

Reflector.—(No. 7.) Diameter, 16 in.

Height—20 ft.

Spacing.—200 ft. centre to centre.

Individual Machines

If the work is close and there is danger of eye-strain, individual lights must be provided.

Lamp.—Tungsten, 25-watt.

Reflector.—No. 8, with diameter of 7 in. (See also No. 10 and 11).

Position.—Attached or hung so that the maximum light reaches tool. The most essential thing is that the lamp shall be completely concealed from the eyes of the operator. On many machines it is important to use adjustable fixtures to hold light in position. (No. 12 and 13.)

Amount of light—Sufficient to avoid eye-strain.

Benches

Lamp.—Tungsten, 25-watt.

Reflector.—No. 8, with diameter of 7 in.

Height.—18 in. above table.

Position.—18 in. from front of table.

Amount of light.—Sufficient to avoid eye-strain.

Drafting Table

Lamp.—Tungsten, 40-watt.

Reflector.—No. 8, with diameter of 7 in.

Height.—42 in. above table.

Position.—Over centre of table or over left-hand corner.

Grinding-Wheels

When grinding-wheels are received in good condition, carefully handled, and properly installed and operated, they are reasonably safe. To make sure that wheels are reasonably safe, see:

That they are sound and free from cracks or flaws.

That they are not operated at a higher speed than recommended by the manufacturer.

That they do not fit too tight or too loose on the spindle.

That the flanges clamp the wheel at the outer edge of the flange. (The flanges should be 'relieved' in the centre, leaving a bearing surface about three-fourths of an inch wide around the outer edge).

That the inside flange is secured to the spindle.

That a washer of blotting or other soft paper is installed between the flanges and the wheel.

That the diameters of the flanges are the same and between one-third and one-half the diameter of the wheel.

That the wheel runs true and in balance.

That the spindle-bearings are neither loose nor so tight as to cause heating.

That oil does not work out on the wheel.

That the nut tightens in the direction in which the wheel revolves.

That the wheel is protected with a guard which would retain it should it burst.

That the arbor-ends and nuts are guarded.

That the belt is guarded at the pulley-contact.

That the tool-rest is securely adjusted close to the wheel surface.

When first starting a grinding-wheel stand to one side for about half a minute, as this is the time when wheels are most likely to burst.

Wear goggles when grinding.—'National Safety Bulletin'.

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The Corrosion and Protection of Iron and Steel*

By D. R. FRENCH†

WHILE in theory iron and steel can be protected, in practice this is not quite so true, though great advances have been made in the past ten years. The methods of protection are classified as follows: Coating the metal with oxide, coating the metal with other resistant metals, and coating the metal with other materials, such as paints or inhibiting chemicals. Cushman and Gardner add another method, treating the metal with materials to cause 'passivity' or to inhibit corrosion.

Use of the first class of coatings depends on the theory that iron oxide can be oxidized no further and a uniform, unbroken surface will protect the metal underneath. Several processes now exist for this purpose. The Gesner process is somewhat as follows: The iron is kept in a coating-retort for 20 minutes at about 600°C. Steam is passed through a red-hot pipe at the bottom of the retort and this steam, which is practically decomposed into hydrogen and oxygen, is allowed to act at low pressure and at intervals for 35 minutes. After this steam treatment a small quantity of a hydro-carbon, such as naphtha, is either poured or sprayed on the metal and allowed to act for 15 minutes. This reduces the red oxide and carbonates the surface.

The Bradley process consists, after cleaning, in heating at low red heat in the presence of hydrogen gas and, later, small quantities of gasoline, after which an hour's time in the furnace produces the oxide coating.

A more recent method is that known as 'Coslettizing'. In this process, after cleaning, the parts are immersed in a boiling-water solution of phosphoric acid containing zinc and iron filings. This immersion varies from one-half hour to three hours, dependent on the thickness of the coating desired. The coating produced is mixed phosphates of iron, mostly from the solution rather than from the metal treated.

In any of these methods the coating produced retards greatly the corrosion of the iron so protected, but sooner or later rust will break through, after which the protection is gone. Recently the Parker process has been developed, where, after cleaning, the iron is dipped in a solution of 'acid meta-phosphate of tungsten, molybdenum, etc.' It is finally treated with a special oil to produce a soft dull-black finish. In 1917, W. H. Allen took out patents in Canada covering a method where 'ferric-acid phosphate', acid calcium-phosphate, or a phosphoric-acid solution of manganese phosphate were used in the immersing baths.

The next method involves the deposition of another metal on iron. Zinc has been found to be the most important of the various metals used. Its cheapness has contributed somewhat to this, also the fact that it is the most electro-positive to iron of any available metal, and finally the ease in applying the coating has been an important item. It can be deposited electrolytically, it can be deposited after vaporizing, as in the Sherardizing process, or it can be deposited by the hot, or dip galvanizing process. This last is the most approved method. The uniformity of the coating depends upon the cleaning of the surface in acid prior to galvanizing. As zinc forms an alloy to iron in addition to the coating, it is considered better than other metals. Unfortunately impurities in the zinc may result in unexpected and serious corrosion and an imperfectly applied coating is bound to do this. Other metals are used, but where they are metals electro-negative to iron the protection can never be permanent. Tin, for instance, is especially valuable, due to its low solution-tension, but the great difficulty lies in getting an economical coating free from pin-holes, which would mean almost instant corrosion.

In either of these classes of methods the coating is good until broken, chemically or physically, then corrosion is bound to start. So far as rusting of iron is concerned, it is immaterial what metal constitutes the coating. The protection of iron by deposits of zinc and its universal rusting when plated with other metals seems to indicate either that electro-deposits of zinc are less porous than those of other metals, or that in the thickness used commercially, all electro-deposits are porous, or on exposure soon become so, and thus the superior protection of zinc is due solely to its galvanic action.

Before considering coatings of other materials, I want to summarize the influence of composition on the liability of the iron itself to corrode. In December 1915 a discussion on corrosion took place before the Faraday Society in England, and I will quote from the report of this meeting: "The main conclusions drawn from the many experiments were the following: With carbon steels the corrosion decreased with the increase of carbon, having a minimum at 0.35% carbon, and then rose again. The addition of a third metal in small amounts almost always increased the corrosion, though the results were not regular, nor always concordant; tungsten conferred no gain at all; vanadium was useful only in tap-water; cobalt developed corrosion up to 11%, manganese steels

*Abstract from the 'Journal' of the American Steel Treaters' Society.

†Dearborn Chemical Co., Chicago.

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were irregular, while chromium had some remarkable effects. No steel was found sufficiently homogeneous to resist corrosion; even the most homogeneous bar-iron (0.07% carbon) contained amorphous intergranular cement, and there were strains and twinned crystals in all the steels. Yet non-homogeneity was not in itself productive of easy corrosion, for a 19.46% chromium steel (0.85% carbon) was not attacked at all in salt solution, though composed of an intimate mixture of carbides and solid solution. The true secret of non-corrodibility seemed to lie in some property, possibly low solution pressure of the solid solution; the solution pressure of iron was not low. Carbides themselves were not attacked; but they acted as acids, providing cathodes, and the pearlite of them promoted attack, though the pearlite might not itself be attacked; the attack seemed to affect rather the ferrite and the solid solution, which formed the matrix for the carbide. Corroded metals containing free carbide were generally found to be corroded with loose carbide particles; but bigger carbide grains would remain embedded in the solid solution, and the boundaries of the grain were similarly fixed."

The above methods of protection indicate what can be done in the mill to increase the permanence of the metal. Another class of methods embody chemical methods of protection after the iron or steel has gone into active service. These methods in a way overlap each other; roughly, they consider the removal of oxygen and its subsequent exclusion, by some sort of protective film, where the metal is exposed to the atmosphere alone and when immersed, and considers, in addition, the reduction of ionization either by interfering ingredients in the solution or the development of electrical currents to offset the electrolytic action of these same solutions.

It was noted by Cushman and Gardner that treatment with concentrated solutions of certain oxidizing agents, as, for instance, chromic acid and its salts, prevent rusting for quite a period of time after such treatment. Such an action is called passivifying, and if a surface so treated can have permanent protection from oxygen, or oxygen compounds, this effect can be made almost permanent. The company that I represent has recently developed a preparation which seems to answer both tests as inhibitor and excluder. Numerous tests in practice have been made and to date we have yet to hear of rusting occurring where this material is in use.

Paints are used with much the same ideas in view, and it has been found that much depends on the character of the pigments as well as the carrier. Much difference of opinion still exists on the protecting action of various paints, but I will summarize some of the results obtained by the American Society for Testing Materials in an extended series of tests. Cushman, Gardner, and P. H. Walker were the principal original workers. Their results indicated that all the zinc pigments, and all the chrome compounds, save chrome-yellow, which is a mixture of chromate and sulphate of lead and carries impurities from its method of manufacture, are classed as inhibitors. Dutch Process white lead also has inhibitive value, though the other white leads and lead pigments are in between, neither inhibiting nor stimulating corrosion; on the other hand, all the carbon pigments, such as lamp-black, carbon-black, and graphite are stimulators, save willow charcoal and bone-black. The former is made from wood and usually contains sufficient alkali to counteract the corrosive properties of the carbon. The iron pigments, as a rule, are also stimulators. Paints to be effective should do two things: they should inhibit corrosion and also exclude air. Many inhibitors do not spread as well in the carrier as do some of the stimulators and frequently two coats of different paints are necessary to get proper protection. Carbon-black and lamp-black, while so stimulating in their actions as to make them unsafe as contact coatings, are frequently used as top coatings, due to their superior properties of covering, and are classed as excluders.

The original work by the American Society for Testing Materials, however, was done with steel plates suspended in distilled water containing the pigments in suspension, and the mixture was agitated by air blown through. Later the water-absorbing properties of these same pigments ground in oil, started tests that indicated that similar results in practice could not be expected, and finally the Atlantic City test fences indicated more nearly what might be expected in practice. These fences were made up of steel plates 24 by 36 in., one-half of which were pickled in sulphuric acid and neutralized in alkali, washed, and preserved from rusting until needed. The relation of pigment to carrier was standardized and all plates were uniformly coated. The plates were then placed on three fences 125 ft. long by 5 ft. high, near Atlantic City, New Jersey, and were periodically inspected until April 1913. The work was started in the fall of 1908. In many cases the original ideas of inhibiting powers of pigments were not confirmed. Zinc oxide, which stood fourth in the early tests, had almost no value as a paint, and American vermillion, which stood No. 35, was 98% inhibitive. The results are all available in the Proceedings of the American Society for Testing Materials, Committee D-1. Practically all the chromium compounds, however, had inhibiting properties.

The protection of immersed iron is often much simpler. In the case of the steam-boiler, the amount of dissolved gases, oxygen and carbon-dioxide, which are stimulators of corrosion, can be combined or so changed by small quantities of the proper chemicals as to make them harmless as far as their action is concerned. Methods have also been developed for neutralizing electrolytic corrosion by the use of electric currents of opposite potential, which form a hydrogen film on the metal.

It will be seen from what has been suggested that the control of corrosion is a complex problem. We seem to know wherein the trouble lies, but the application of the remedy is much more difficult than the diagnosis of the trouble. With all the knowledge at hand we do not seem to have developed a rust-proof iron or a fool-proof rust-proofing method.

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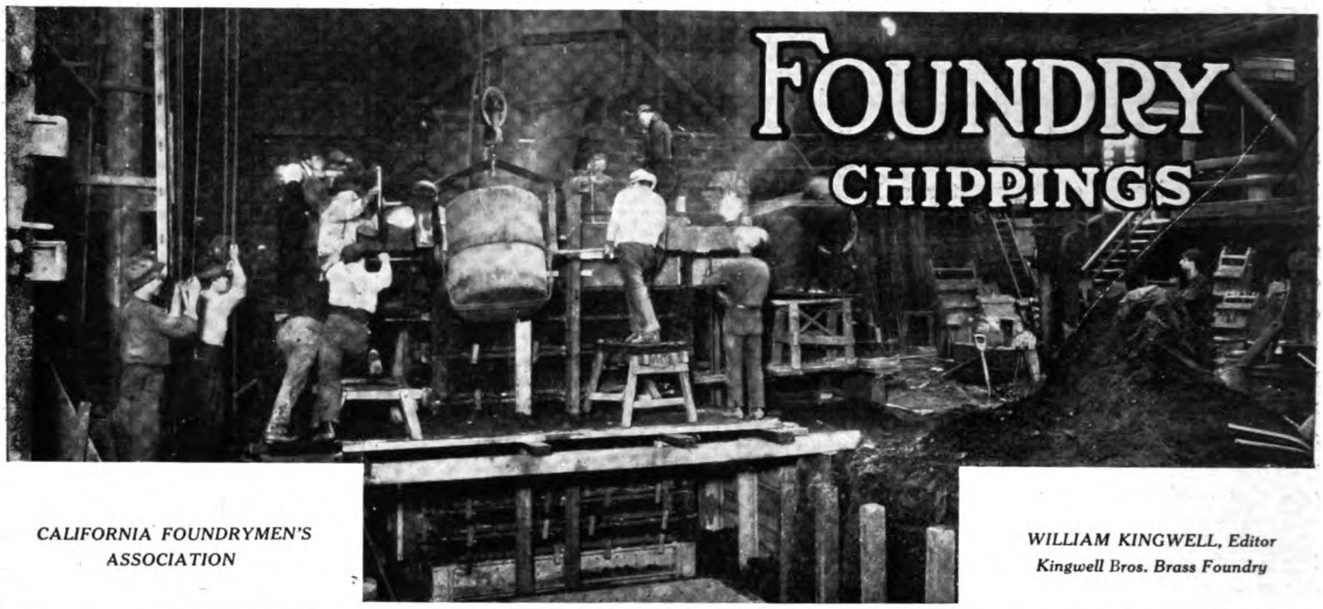

CALIFORNIA FOUNDRYMEN'S ASSOCIATION

WILLIAM KINGWELL, Editor
Kingwell Bros. Brass Foundry

Meeting of American Foundrymen's Association at Philadelphia

The twenty-fourth annual meeting of the American Foundrymen's Association will be held at Philadelphia, September 29 to October 3. Besides delegations from all over the United States, it is expected that a number of British, French, and other European foundrymen will be present. It was at Philadelphia that the American Foundrymen's Association was organized in 1896 as a result of a movement led by the Philadelphia Foundrymen's Association. Efforts will be made to make both the entertainment and the technical side of the program unusually attractive. Among the technical papers for which arrangements already have been made are the following: 'Results of an Investigation of Steel Castings on German Submarines', by William Campbell, Columbia University; 'Training Men for Foundry Work', by C. C. Schoen, training section, U. S. Department of Labor; 'The Comparative Qualities of Electric and Converter Steel Castings', by John Howe Hall, Taylor-Wharton Iron & Steel Co.; 'Experiments with Melting High-Sulphur Malleable Scrap', by A. W. Merrick, General Electric Co., Schenectady, N. Y.; 'The Side-Blow Steel-Converter and Its Possibilities for the Gray-Iron Foundry', by George P. Fisher, Whiting Foundry Equipment Co.; 'Micro-motion Study for Foundrymen', illustrated by motion pictures, by Frank B. Gilbreth; 'Electric Furnaces for Foundry Use, Especially for Annealing Steel Castings', illustrated by motion pictures, by T. F. Baily, Electric Furnace Co.; 'Methods for Determining When Malleable Iron is Over or Under Annealed', by W. P. Putnam, Detroit Testing Laboratory; 'Relation Between Machining Qualities of Malleable Castings and Physical Tests', by Edwin K. Smith, Wisconsin Malleable Iron Co.; 'How to Secure Best Results in Combining Hoisting Apparatus with Molding Machines', by W. C. Briggs, Shepard Electric Crane & Hoist Co.; 'Concrete Foundry-Floors', by H. H. Haley, American Foundry Equipment Co.; 'Personnel Problems of Modern Industry', by C. D. Dyer, Jr., consulting engineer, Philadelphia; and 'Foundry Sand-Handling Equipment', by H. L. McKinnon, the C. O. Bartlett & Snow Company.

Off and On

The infernal revenue collectors are in doubt as to whether corsets are underwear or a luxury. As they are worn over the underwear and under the overwear, it seems to the masculine mind that they should be classed as partitions.

Forget about your neighbors and begin to compete with yourself and your possibilities. That's the stuff.

Don't let the thrift stamp habit die. Suggested as a war measure, it should be more strongly recommended in peace times.

Again, we have to ask, "Why do people have to advertise that they are '100 per cent American'?" Is it because they fear someone might think that they are not?

It is better to pay promptly and collect as one pays, rather than pay as one collects. Get that? Read it again; it's good medicine.

Shaking dice for nut sundaes and malted milk will never make hubby late for the evening meal.

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Charging the Cupola and Soaking the Iron

By W. W. ELLIS

IN discussing, for the benefit of the student, the subject of charging the cupola, we should start from the bottom-plates. So assuming that the lining, breast, and bottom-plates are all fixed up, the cupola is now ready for the sand-bed. I might state here, though, that we make a permanent breast. That is, we brick up the breast with firebrick, so that it will last several months. The tap-hole alone has to be touched up every day when fixing the lining of the cupola. This method saves considerable time and worry, as there is never any fear of the breast giving way. The next operation after the bottom-plates are in place is to get a load of rough sand from under the cupola-drop, making a bed of this sand about two inches deep. This sand is full of fine coke and cinders, and acts as a cinder-bed to carry off the gases while the iron is melting. We now get a load of good sand from the molding-floor to put on top of the rough sand, making the bed in all about four inches deep. We now tamp this bed about the same as a bed in the molding-floor for a large casting, taking care to slope it toward the tap-hole from every direction so that all the iron can drain from the cupola.

If wood is used to fire the coke, the general practice is to get a sackful of wood shavings and dump them on the sand-bed. These shavings will help fire the wood, and also help protect the sand-bed from being disturbed and cut when dropping the wood from the charging-door into the cupola. When sufficient wood has been charged, nearly all the bed-coke should be dumped on top of it. The fire can then be started when convenient. However, the most up-to-date method of firing the coke is with an oil torch, without using any wood. The torch is inserted through the breast, which is made up later with sand after the fire has been well started. When the fire has been burning an hour or so, the lining of the cupola will be fairly dry and hot, unless the lining material has been daubed on extra thick. This is a mistake, because, if the lining is too thick, it will crack while drying, and is likely to scale when charging begins. The remainder of the bed-coke should now be added and leveled. The cupola is then ready for charging the iron. When the iron is first dumped on the coke-bed, its weight will settle the coke from 8 to 12 in., but that is taken care of when the right height of the bed is determined by the method explained later.

As soon as possible after the cupola is charged as high as the charging-door, I believe the blast should be put on, because it is my opinion that the longer the iron lies on top of the burning coke in a semi-melted condition, the more sulphur it will absorb. In support of this opinion is the practice of converter-steel men of never using first charges when engaged on government work to strict specifications. The reason is that first charges always have a higher sulphur content than the following charges, although all the material charged may originally have had the same composition. I believe that few foundrymen would think of casting their fine particular work from the first tap. C. M. Henderson, in commenting on my book, 'The Metal Mixer', in the May issue of 'Metal Trades', under the heading of 'Soaking Iron in the Cupola', says "with but one exception, I am in accord with his manner of operating it. He states, 'It is not very good practice to let the iron soak too long in the cupola before starting the blast, as the iron absorbs more or less sulphur from the fuel during that time'."

Mr. Henderson says "this is a mooted question well worth a thorough investigation by every foundryman. An unbiased investigation would cost nothing and would convince many that a reasonable soaking has advantages and no disadvantages. The majority of melters agree with Mr. Ellis in starting the blast as soon as the cupola is filled to the charging-door, in the belief that any further delay will permit the iron to absorb sulphur from the fuel, and also that the fuel is being burned away and wasted." Mr. Henderson does not deny that first charges contain more sulphur than later ones, but contends that such is the case whether the iron has been allowed to soak or not. He quotes other authorities in favor of long soaking, besides making some experiments himself, "which showed on every count in favor of soaking." He says "iron will not begin to melt in the cupola until after the blast is put on, and has no affinity for sulphur until it becomes molten. In the latter state it will readily absorb sulphur until its temperature approaches 3000°F. and at a higher heat will expel much of this absorbed sulphur." I have not been in a position to do much experimenting, but base my opinions chiefly on personal observations. One thing, however, I would like to have explained, namely, if iron does not absorb sulphur until it becomes molten, why should Mr. Mulcahy mention in a note at the bottom of the reference card of 'Approximate Analysis of Various Material' (prepared for the California Foundrymen's Association) "The amount of sulphur in grate-bars will depend on service bar has been subjected to." Mr. Mulcahy must think that iron absorbs sulphur before it melts. However, as Mr. Henderson says, "The soaking of iron is a mooted question." And, like him, I would like to hear the opinion of other foundrymen on this subject. However, until further proof is presented I will continue to believe that soaking is not necessary, and that

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it is always best to get the metal melting as soon as possible after the cupola has been charged.

This is why I believe that we should not get the coke bed too high, and not put too heavy a first charge of iron on the bed. I believe the melter that will take the trouble to find the proper height of the coke-bed for his particular cupola, and then make all his charges of iron from first to last as near the same weight as possible, will get a more uniform grade and a more even flow of iron with far less coke-consumption than the man that crowds his coke-bed to the limit with an extra-heavy first charge of iron. The proper practice calls for a uniform weight for all charges. This weight is determined by multiplying by 10 the weight of coke required to fill a space 4 to 5 in. high in the cupola. That is, if it takes 150 lb. of coke to fill a space 4 to 5 in. high in the cupola the iron charges should weigh about 1500 lb. Foundrymen have proved by experiment that the melting-zone averages 4 to 5 in. deep, and they have also found that faily good coke will melt 10 times its weight in iron. When that amount of iron is melted, the bed is ready for another layer of coke.

When I speak of a layer of coke, I do not mean that it is necessary to put a layer of coke all over the inside area of the cupola. That rule is only used as a standard for figuring the iron charges. In fact, it has been proved that the best results have been obtained by putting all the coke in the centre and all the iron as close to the lining as possible, except when making different mixtures, which must be separated by the coke. By this method of charging the lining will last much longer, and the rate of consumption of coke will be entirely dependent upon the temperature of the iron required in the ladle.

When the bed is the proper height, only the top 4 or 5 in. does the real melting. If the bed is higher than it should be, the extra coke will be burned and wasted until it lets the iron down to the real melting-zone, which will vary from 15 to 28 in. above the tuyeres, according to whether the blast is high or low. The main point is to find the proper height of bed for every cupola. The best way to determine this is by observing the time required for the iron to drop lively, as seen through tuyere-glasses, after the blast has been put-on. If it takes more than three minutes at the most, the bed is too high, and the extra time will be spent in burning coke that is not required. It is generally upon high coke-beds that extra heavy first charges of iron are put, because the melter believes that so much coke on the bed ought to melt a much heavier first charge than the rest of the charges. This, however, is not so.

Another reason for heavy first charges, and a fairly pardonable one too, is that most foundries have some special mixtures to make, different from their regular run of work. If these happen to be heavier than the regular charges, the bed is considered the best place for them, so as to get them down and out of the way of their regular mixtures. But, as we must put a heavy split of coke between two different mixtures, the bed is built up somewhat, according to the amount it has lost through having to melt a heavy first charge. I believe that having to put a heavy split of coke between two first different mixtures has saved many a coke-bed from getting dangerously low without the melter being aware of it. Here, however, is the point: We all know that if we wish to retard the melting between two different mixtures, we must put a heavy split of coke between them. By so doing we keep the iron high above the melting-zone, until part of the coke is burned away, when the top part, namely the last 4 in. of the coke, will drop to a point where it can melt the iron above it. The same reasoning applies to the high bed. It is only the last or top 4 in. that does the real melting, and, like the heavy split of coke, even that 4 in. will not melt iron until it drops to the real melting-zone, and even then, it will only melt so much, so if burdened with an extra heavy first charge of iron, the bed proper is bound to suffer, and can only be built up again at the expense of irregular iron melting and expensive extra coke, which would not be the case if all the charges had been made as near as possible what they should be according to the size of the cupola. That is why I maintain that if the melter will take the trouble to find the exact height the coke-bed should be for his particular cupola, and then will make all his charges of both iron and coke as near as possible what they should be, he will stand a much better show of getting a more even grade and a more continuous flow of iron, with much less coke consumption, than the man who crowds his coke-bed to the limit with an extra heavy first charge of iron.

Poor Cost Methods the Cause of Foundry Failures

'Dun's Review' for January 11, 1919, gives the number of failures in the foundry and some other lines as follows:

In 1918 the average amount from which American firms in the 'Iron, Foundries, and Nails' class failed was $44,500, as against $31,694 for all classes of business. Only two other of the 15 classes of manufacturers (Glass, Earthenware and Brick, and Chemicals and Drugs) exceeded this average. The smallest average was in Paints and Drugs, $2450.

Yet the 'Iron, Foundries, and Nails' class did better in 1918 than in any year since 1914, inclusive; namely with only $1,209,574 liabilities as against $4,184,220 for 1914 and $3,999,092 in 1915.

Any foundry that makes estimates 'by guess and by gosh', is in my eyes a bad risk. Bidding too high, it loses orders; bidding too low, it may get them and wish it hadn't.

I have found them selling castings for six cents, that cost over ten.—Grimshaw's Bulletin.

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The Foundryman

HOW doth the BUSY BUZZY FOUNDRYMAN delight to trip daily into the august PRESENCE of the blithesome PURCHASING AGENT and ask him with FEARSOME TONES if there is any JOB in sight; and how doth the same P. A. which was mentioned heretofore as noted above DELIGHT to take his FOOTIES from off the GOLDEN OAK and put the four fingers of his left hand against the selfsame four on his right hand and PEER over his GLASSES and HEM and HAW and say that he might CONSIDER giving an ORDER provided however that the foundrymen will sharpen his EVERSHARP still sharper and in fact will come right down to earth; and he will COGITATE and casually mention that he has a BROTHER on his parents' side, who KNOWS a man that lives in PADUCA way back EAST in KANSAS, and that man keeps a BOARDER, who is in the IRON BUSINESS, and who has WHISPERED that pig iron is GOING DOWN, and also that before PIG IRON does go down, the FOUNDRYMAN will of course sell his CASTINGS cheaper, and also this self same P. A. says he has it on good AUTHORITY that the DEMOCRATS will stay in power, which of course means CHEAPER CASTINGS.

The poor Foundryman had intended to ask TEN CENTS a pound for the job, but he SHUFFLES and SNIFFLES and feels so bad for the world and the future that he cutteth the price to SIX CENTS, and if he had said TWO CENTS the P. A. would have said the price is TOO HIGH with the HIGH COST OF BUYING as it is now, and the sad sad foundryman goeth in between the SWINGING DOORS and seeketh solace in a TALL ONE with FOAM on the top and regretteth his action for perforce he seeth that, if there is really a job in sight, it is just as easy to get ten cents as it is to get two cents, and he KICKETH HIMSELF for being a many-tinted JACKASS, and the next morning, when he arriveth at his place of BUSINESS, he finds a LETTER on his desk, which readeth "GREETINGS—We the UNDERSIGNED amalgamated UNION do herewith and hereby believe it is for the GOOD of the TRADE that all our WORKERS shall get a longer wage from now on, and it shall be RETROACTIVE from some time LAST FALL, we don't just REMEMBER the date, but it will be then anyway."

The Foundryman hiketh to his ASSOCIATION, and he says this is a DEMNITION OUTRAGE twice in the same place, and I won't stand for it, and he FIGHTETH and SCRAPPETH and loseth money, and then UNCLE SAM says give 'em what they WANT or they may even get real mad and STICK OUT THEIR TONGUE at you, and the foundryman GIVETH and goes in a CORNER and kicketh himself again for a bally Jackass.

Then comes a day when the Foundryman WAKES UP almost; at least as much as a foundryman CAN WAKE UP and he says—"I HOLLER when I have to pay more WAGES and I go to my ASSOCIATION and I do get some COMFORT, but why don't I HOLLER when the P.A. gives me LESS wages instead of more, and why don't I go to my ASSOCIATION with that. I spend all my TIME to keep from PAYING out more on the COST but I swallow it when I get cut down on the PRICE, and so he GRABBETH his hat, the one with CINDER HOLES burned in the top, and he STRIDETH into the office of the P. A., and he says: here, you FOUR-EYED BAZUZULIUM, I must have twenty cents a pound for that job, and now I'm going down to the ASSOCIATION, and if any wild eyed COMPETITOR gets it for any less I'm going to PUNCH HIS BEEZER for him, and that's got to go; see, and this TIME I'm going to do the STICKING, and any job that won't pay a PROFIT is a SCAB JOB, and I won't touch it and no one else will, and I'm out to tell the PURCHASING PUBLIC that I'm a JOLLY MERRY FOUNDRYMAN, and I'm going to get my price, and any SCAB PRICE CUTTER is going to get HIS: believe me.

MORAL: IF HALF AS MUCH TIME WAS SPENT ON BUCKING LOW PRICES AS IS SPENT ON BUCKING HIGH WAGES WE WOULD ALL GET SOMEWHERE.

CHEESE IT.

Morning Exercise for the Tired Businessman

How to Get Care and Trouble Out of the System.

1. Rise 7:00 am.

2. Stand in middle of room. Raise arms slowly overhead, take deep breath and say "Damn the Government," lowering arms in attitude of despair. Ten times.

3. Extend body, face downward, on floor. Cover eyes with hands. Kick heels, think of the railroads, and weep. Till Dry.

4. Kneel. Wring hands. Meditate upon the labor unions and groan, 150 times.

5. Assume sitting position. Hands on hips. Sway gently to and fro and concentrate upon Mr. Burleson until a generous frothing at the mouth sets in. Till exhausted.

6. Collapse on floor. Grovel vigorously. Think of the income tax and gnash teeth as in anger. Ad. Lib.

7. Note: Observe this simple regime every morning before breakfast and you will reach the office with most of the cares and troubles of the day already out of your system.—Boston News Bureau.

Examining Steel by X-Rays

Considerable progress is being made in the study of steel for defects by means of X-rays. Metal as much as 4 in. thick has been examined in this way, and apparatus is now being constructed for handling even thicker pieces. With the chance of hidden flaws eliminated, lower factors of safety will be admissible in design.

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Why Not Cores?

MANY times patterns are received in the foundry which, if they were constructed differently, would permit the saving of many hours of labor of the molder. In addition, these changes of construction would to a great extent remove the element of risk. I once believed that the blame for such poorly designed patterns belonged to the pattern-shop, where naturally the desire is to save time, although the result frequently is that the molder receives a wooden casting instead of a practical pattern.

However, after discussion with several pattern-makers, I find that the fault really lies with the average foundryman. These pattern-makers appreciated the advantage of core-prints and core-boxes, and stated that the cost of making patterns with details or ugly lifts worked out in the body of the pattern would be little if any less than if the same patterns were designed for cores. They reported that the average foundryman is opposed to using core-boxes wherever they can be avoided.

The classes of work to which I refer are as follows:

1. A chain-wheel or 'wildcat'. This is generally made to mold in a three-part mold. The cheek causes slow work, and it takes a skilled molder to avoid a poor casting. If the cheek is large, it will have to be dried thoroughly, otherwise there is a great risk of cuts, scabs, or other defects. On the other hand, if a solid pattern and core-box is furnished, any molder can put up the mold. The core is simple to make, and the casting will do the work required of it, as the chain will fit perfectly, if the wheel is made in this manner.

2. Patterns with deep lift in the cope. This class of work requires a specially fitted cope, and is generally slow to ram and to finish. Frequently a core-print on the side or top of the pattern and a plain brick of a core would solve the problem.

3. Patterns where cheeks can be avoided. A little study by the molder and pattern-maker in laying out such a job will solve the problem. For instance, in the standard 1400-hp. marine engine of the U. S. Shipping Board, the intermediate cylinder is of unusual design and at first glance it would seem that two cheeks would be required. After considerable study both cheeks were eliminated, all the core-parts of the mold made very plain, and the final pattern was entirely satisfactory. On this job the flask was 7 ft. by 6 in. by 9 ft., so that it is easy to see what a saving of labor was obtained by having everything in the drag as compared with having two cheeks. The time required for making all the core-sections of the mold, which consisted of a bottom flange and two bricks to give clearance for setting the exhaust-core, was about two days. Besides the saving in labor, there were other advantages in having the whole mold in the drag. First, the mold was parallel and true to pattern, a condition not always attained where large cheeks are used, as there is always danger of sagging and twisting. Second, a large saving was made in floor-space when finishing the mold, as the only space needed was for the cope, instead of a cope and two cheeks, if the latter had been used.

4. Molds where trouble is experienced on account of flanges in the drag. Generally the pattern has either a loose flange or a flange in segments to be drawn-in. Either method requires good securing of hanging sand, and there is always danger of dirty and rough flanges because of small drops. If there is a loose flange the molder is compelled to cover it with cake core or make a joint and ram an extra cope in order to remove the flange-pattern.

If, however, the pattern is constructed according to

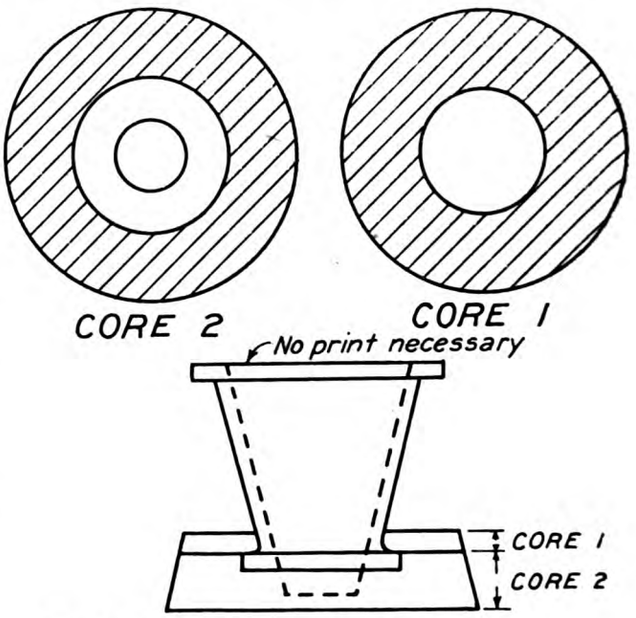

FIG. 1. METHOD OF MAKING CORES AND PATTERN

Fig. 1, the job is easy, safe, and clean. The flange is made in two cores, core No. 1 being a plain ring, which, unless very large, requires no rods nor vents. Core No. 2 is also plain. By using this method, the drag is rammed the same as any ordinary job until the sand has been rammed to the top of the print. The core-print is then drawn and cores No. 1 and 2 set in the print. The remainder of the drag is then rammed.

The advantage of making flanges by this method was clearly demonstrated to me a few months ago. I received a large order of 10 by 6 in. reducer-pipes. The pattern furnished, like all pipe-patterns, was split in halves. In other shops, four of these molds had been a day's work. In my opinion, no complaint could be made about this

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output, since the flask was 20 by 30 in. with an 18-in. drag and an 18-in. cope.

By changing the design so as to mold on end and making the bottom flange by the method illustrated in Fig. 1, the output was increased to 10 molds per day, requiring one molder for eight hours and one core-maker for two hours, a total of 10 hours labor in all. The output was therefore one mold per hour as against one mold per two hours with the split pattern.

There are a number of other reasons in favor of using cores in molding, but those already given are sufficient to show that all is not loss that is made on the core-bench. By using judgment as to when not to use a core, many difficult and awkward jobs can be made simply and at a financial saving.

A. KRANK.

Book of a Thousand Excuses for All Persons Connected With the Foundry Trade

CHAPTER II

FOUNDRY OWNERS' EXCUSE FOR REDUCING THE PRICE OF CASTINGS

On first thought it would appear to be an almost impossible task to find any excuse for reducing the price of castings at the present time.

Anyone suggesting the possibility of an excuse for a reduction in the price of castings would immediately be placed on the waiting list as a candidate for membership of the Napa or Stockton Insane Asylum Association.

If the owner of a foundry merely suggests to the foreman that the men should be willing to work for less wages, (now that the War is over and living expenses are so much lower) he receives a look of utter hopelessness and is considered a helpless nut, proper food for the first squirrel that comes along.

The workman is instructed by the business agent of the union that he must insist on higher wages and shorter hours plus easier work.

The scrap-iron salesman is told to boost the price of scrap or get off the job (for the boss needs the money). The cost of overhead has doubled on account of only 50% of normal production. In the face of all this the purchasing agent is instructed to purchase castings for less money or die. The poor foundryman starts scratching away at the three or perhaps four red or white hairs left on his dome and tries to find an excuse for meeting the views of his customer. If he is a progressive foundryman he sends for the cost expert and tells him that his figures are rotten and to get busy in figuring out a lower cost. The expert gets busy and figures the costs still higher, and informs the foundryman that it will be necessary for him to raise prices or bust. The cost expert is fired after being told that foundries had existed before cost experts were thought of. In sheer desperation the poor foundryman proceeds to sell castings at a little less than the cost of raw materials, and hopes that he may get by or that something may turn up (perhaps another war with Germany) before the sheriff gets him.

However we do find a few of the more case-hardened foundrymen using excuses such as the following:

1. Kindly disposed and wishes to bull the customer along.
2. Charity begins at home.
3. Job taken for a filler in.
4. Cleans the castings himself.
5. Has only ½% loss in cupola.
6. Gets his fire-brick for nothing.
7. No overhead to pay.
8. Half a loaf is better than none.
9. Jim Jones can do it, so can I.
10. Doesn't use any pig-iron.
11. Job taken to get a start with new firm.
12. Wife makes all the cores.
13. High prices can't keep up all the time.
14. Had a lot of expensive material on hand which must be gotten rid of.
15. Expected the molders to double the output.
16. Needs the work to fill up the new foundry.
17. Doesn't use any core-flour.
18. Have been in the foundry business for fifty years and should know any business.
19. Just started in the foundry game and will show these old mossbacks how to run a foundry.
20. Thought the job was cast solid, no cores. And so it goes on, one rotten excuse after the other. The majority of these excuses are used by the foundryman to ease his conscience for doing something which is impossible to explain, even to himself. It would seem advisable for the foundryman to donate the whole outfit to the Red Cross or the Y. M. C. A. in a lump. Giving away his outfit in small driblets is not especially appreciated and in the end spells disaster and disgrace, while if he makes a big splurge he will be called a great philanthropist.

Chapter III is the Pig-Iron Dealers excuses for non-delivery of pig-iron on time. This will be extremely interesting and we hope that the dealers will not miss this opportunity of standardizing their stock in trade.

C. J. P. H.

THE EDITOR was a believer in 'yellow' journalism and ran this as a leading editorial: "The business man of this town who is in the habit of hugging his stenographer had better quit, or we will publish his name."

The next day thirty-seven business men called at the office, paid up their subscriptions a year in advance, left thirty-seven columns of advertising to run indefinitely, and told the editor not to pay any attention to fool stories.—'The Yellow Strand'.

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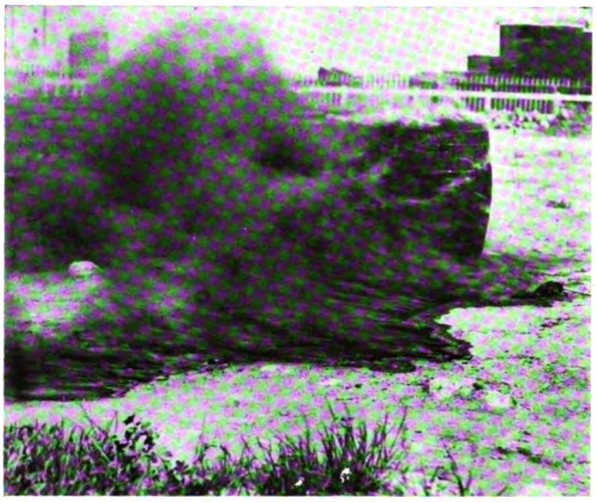
INDUSTRIAL EQUIPMENT

FOAMITE FOR EXTINGUISHING FIRES

At a fire in a licorice factory some waste licorice solution was used in conjunction with hand extinguishers to put out the fire. To the surprise of the amateur firemen the combination made a tremendous foam which covered the fire like a blanket. This accidental discovery resulted in the development of Foamite Firefoam, a remarkably efficient means of extinguishing fires. The fire-fighting ap-



Before—

paratus manufactured by the Foamite Firefoam Co. does not differ in appearance from the usual hand-extinguisher or from the cylinder and other equipment furnished with the ordinary chemical-engine. The interior arrangement of the apparatus is different, however, as equal quantities of two liquids are mixed when the extinguisher is dis-

—And After

charged. One solution is licorice water in which sodium bicarbonate has been dissolved. The other is a solution of aluminum sulphate. When they are mixed, over eight times their volume of carbon di-oxide is liberated, and is held in a heavy tenacious lather.

Fires are usually extinguished either by cooling the fuel below the combustion temperature or by cutting off the supply of oxygen with a film of water. This latter result may be accomplished by gas that will not support combustion, such as carbon di-oxide. The difficulty with the ordinary chemical extinguisher, which depends upon carbon di-oxide to smother the fire, is that the liberated gas, although heavier than air, is soon dissipated by diffusion and air currents, and the effect is only temporary at best. The Foamite Firefoam extinguishers overcome this disadvantage as the carbon di-oxide is held in a leather-like foam, which is tough and difficult to stir because of some chalk-like material, which is thrown out of solution when the two liquids are mixed. The foam remains in place for a long time and finally dries to a light powder which may be collected with a broom or even shoveled. The solutions do not injure clothing or other material; the powder merely has to be brushed off.

One of the most spectacular uses of Foamite Firefoam is in the protection of the large oil and gasoline storage-tanks. Several million dollars have been invested by oil producers in Foamite Firefoam equipment in this State alone. When a tank catches fire a stream of Foamite is turned upon it from a central mixing station. It spreads over the surface of the oil and smothers the fire. No tanks have ever been lost that were equipped with this apparatus, although over 12,000 oil-tanks have now been protected. Both the Standard and the Associated Oil Co. of California have made large purchases of this equipment recently, and the Union Oil Co. is now installing a Foamite system at an aggregate cost of over $250,000.

This fire-fighting apparatus is now manufactured in sizes ranging from a 3-gal. fire-pail and a 2½-gal. hand-extinguisher to 500 and 800-gal. engines mounted on wheeled trucks. Special apparatus including engines of unusual design or size may also be built. This means of fire-protection possesses one peculiar advantage. It may be designed or installed upon a strictly scientific basis. If a given area is to be protected the amount of chemicals necessary therefor may be calculated.

Firefoam is approved by the National Underwriters Laboratories of Chicago and the Associated Mutual Companies of Boston. Several demonstrations have already been given in this State before representatives of the Pacific Board of Underwriters, of insurance companies, and of large manufacturing corporations, and it has been endorsed by all those who have seen it used. It is particularly recommended for shops in which there is a special fire-hazard, such as oily waste or oil-soaked floors or where oil or gasoline is used or stored. The apparatus is handled by the Pacific Foamite Firefoam Company, Inc., Mills building, San Francisco.

ELECTRIC TOOL-TEMPERING FURNACE

An electric tool-tempering furnace, which uses barium-chloride and salt, is proving highly successful in the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co. The chief advantages of this type of furnace over those using gas, coke, oil, or wood, are constancy and ease of control of heat, cleanliness, equal heating throughout the specific part of the tool to be tempered, low cost of operation, and excellence of the finished work.

The photograph illustrates the simple construction of the furnace. The outer shell, a cast-iron cylinder, is about 3 ft. high and 3½ ft. diam. It is packed with fire-brick and occasionally a layer of asbestos. The circular reservoir in the centre, which forms the operating part of the furnace, is 12 in. diam. and 14 in. deep. Heat is supplied by two pairs of electrodes, built-in on opposite sides of the walls of the reservoir. The electrodes operate on a 16 to 30 volt alternating-current circuit. Carbon sticks are placed between the electrodes in the reservoir to complete the circuit.

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The current is started on the 30-volt circuit. Salt is fed into the reservoir and, when it is melted, it acts as a conductor and completes the circuit. The carbon sticks are taken out. A mixture of barium chloride and salt is then fed into the reservoir, the final proportion being about 60% barium chloride.

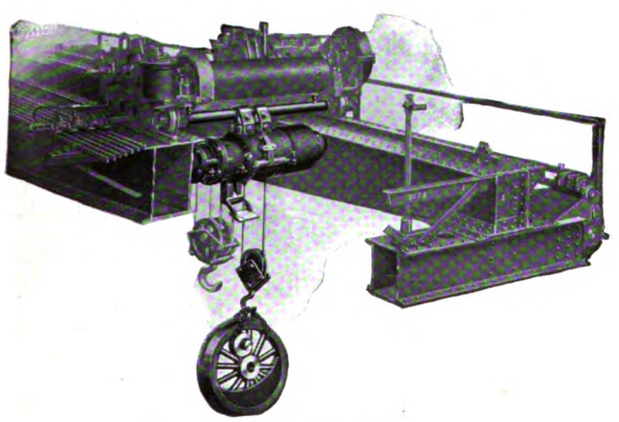
When the temperature of the liquid reaches 1425°F., the voltage is lowered. The current regulation at the switch-

Electric Tool-Tempering Furnace

board gives a quick and easy method of control so that the temperature of the liquid can be held at any pre-determined degree of heat required for each specific tool. The liquid, kept at one temperature, heats the tool uniformly from surface to centre and eliminates soft spots in the finished tool, which is seldom possible when a tool is exposed to a direct or indirect flame. The furnace throws off very little heat so that it meets with the approval of the workmen.

AUXILIARY HOIST FOR TRAVELING CRANES

A simple and practical auxiliary hoist for attaching to any standard overhead electric traveling crane, as shown by the illustration, has recently been developed by the N. B. Payne & Co., 25 Church street, New York. The hoist does not require any more room overhead, does not require an extra trolley, does not shorten the travel of the trolley



Auxiliary Hoist

on the bridge, nor does it interfere with the accessibility of the main hoist. A traveling crane in a day's work usually handles a far greater number of light loads than heavy loads. Since cranes for lifting heavy loads are slow-moving, their use results in a serious loss of time if they also handle the light loads. Thus a 20-ton crane, direct-current, with a hoisting speed of 12 ft. per minute per load will handle a three-ton load at but slightly greater speed. But, with the auxiliary hoist, a light load of say three tons may be handled at a much higher speed—two to ten times as fast as the speed of the main crane.

Attachment of this auxiliary also effects an important power saving. Often the hook and block of the main crane together weigh more than the load. The auxiliary hook and block being much lighter it is evident that the power saving in a year's time is an important item. The labor saving with the auxiliary hoist is another important item, especially when a gang of men must wait for a small piece being slowly moved by a large crane. This is a vexing circumstance with which many foremen are familiar. The auxiliary eliminates this labor loss.

Ordinarily from one to five ton standard auxiliary hoists are supplied by the makers to meet the usual requirements. Larger special sizes, however, are furnished where specified.

By the application of this auxiliary attachment any standard single-hoist electric traveling crane may be equipped with two lines for drop-bucket service. The control may be arranged from cage, floor, or pulpit to suit the crane to which it is applied.

NEW PYROMETER ALLOY FOR BRASS AND BRONZE FURNACES

Wrong pouring-temperatures are probably the principal cause of faulty brass and bronze castings. This factor enters not only into the production of the casting itself, but the properties of the finished article are also affected. The

Fig. 1. Using Pyrometer

chief difficulty in measuring the temperature of the molten metal by the use of the ordinary thermo-electric pyrometer has been the lack of a suitable protection-tube for the thermo-couple. The necessity for a quick reading limits the thickness of the tube-wall. At the same time, the tube must

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successfully withstand the action of the molten metal. Refractory tubes are not satisfactory because they are too fragile for ordinary foundry use, and are likely to break under the sudden temperature changes that are unavoidable.

The Hoskins Manufacturing Co., of Detroit, has recently developed an alloy of nickel and iron known as 'chromon', which, up to 2200°F., is resistant to all kinds of brass and to all types of bronze except those high in phosphorus. Fig. 1 shows the complete outfit in use, and Fig. 2 the construction of the thermo-couple and protection-tube. The tube

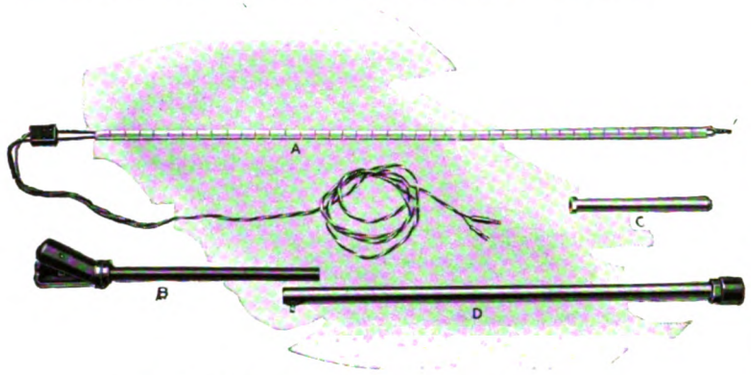


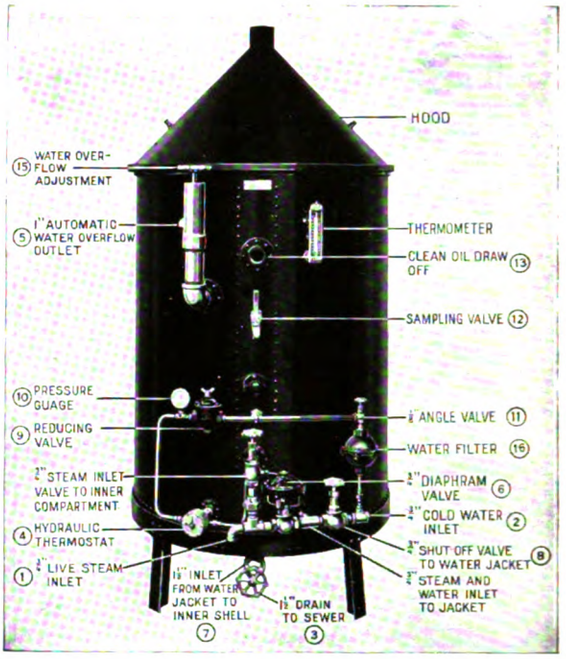
Fig. 2. Thermo-Couple and Protection Tube

consists of three parts. Section B telescopes into the upper end of the seamless steel tube D, and the protection-tube proper, marked C, is held in the lower end. The thermo-couple, A, is entirely encased in the tube and can easily be renewed. When the molten metal ultimately destroys the protection-tube, it can readily be replaced with a new one. The life of the tube is expressed in number of readings rather than in hours, because it should not be immersed in the metal continuously but only for a short time required for a reading. As many as 338 readings have been obtained with one tube, but any general statement of the number of readings to be expected would be misleading, because of the variations caused by composition of metal and temperature.

RICHARDSON-PHENIX OIL-RECLAIMERS IN AEROPLANE SERVICE

The operation of the Richardson-Phenix Co. oil-reclaimers at the flying fields in the United States was remarkably successful. When they were first introduced there was considerable prejudice on the part of officers and pilots to the use of what they called 'second-hand oil'. It was the practice at the different aviation fields to remove the oil from the crank-case of the aeroplane-engines at the end of four to six hours. This was because the oil became rather heavily loaded with carbon and had a bad appearance, and also because its viscosity was reduced, because of the leakage of gas on the compression-stroke of the engine past the piston-ring. This gas re-condenses in the crank-case and dilutes the oil, decreasing the viscosity. It was found by experiments that the gasoline in solution in the lubricating oil could be removed by blowing steam through it. In some instances oil that had been used in a truck for a week contained as much as 30% gasoline.

When the men at the fields became accustomed to using reclaimed oil, many preferred it to new oil, because experiments showed that the reclaimed oil deposited less carbon on the cylinder-heads and piston-heads than the new oil. This seems to be because there are certain constituents in most oils that will break down under the action of heat. After the oil has been used once some of these carbon-forming constituents have been broken down. If the oil is satisfactorily purified in a reclaimer, and then used over again, a large proportion of the constituents that would form carbon have been removed. Some of the fields reclaimed their oil 12 to 15 times. At the time of the armistice, about 40,000 gallons of oil per month were being re-



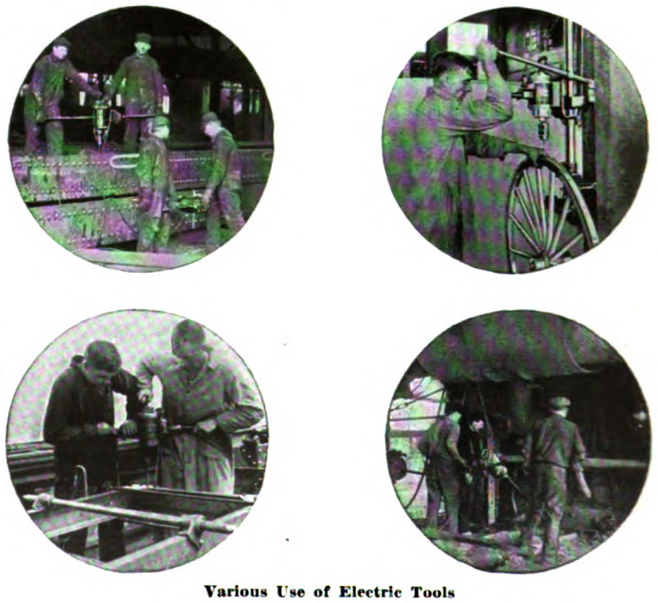
Oil-Reclaimer

claimed at various fields in the United States at a cost of about 2c. per gallon.

The reclaimer can be successfully used for removing carbon from oils from any type of engine, including automobiles, trucks, tractors, and Diesel and semi-Diesel engines.

PORTABLE ELECTRIC TOOLS

The prime advantage of the portable electric drill lies in 'carrying the tool to the work'. This advantage is augmented by the speed with which the work can be done and by the fact that the tool frequently is utilized for work which formerly required special machinery. The efficiency of a portable electric drill when substituted for expensive



Various Use of Electric Tools

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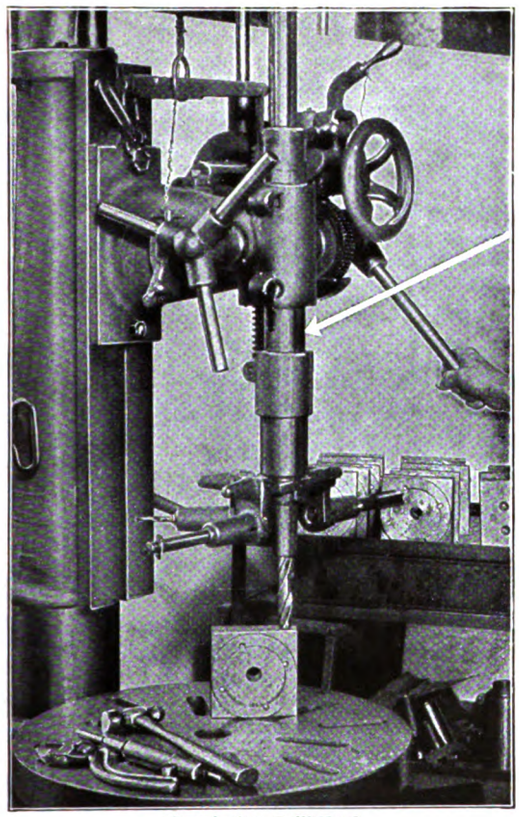
machinery is demonstrated in the plant of the Sterling Engine Co., of Buffalo, New York. Here a portable electric drill is used to drill ¼-in. holes in drop-forged crank-shafts the holes being drilled at an angle of 29° with the shaft. The drill is attached to an inexpensive frame made in the Sterling works. Provision is made for moving the drill vertically and horizontally and also for swinging the drill either right or left to the required angle. The two operations of drilling and reaming 'in place' are used to a considerable extent in automobile-assembly work and, with the exception of holes involving micrometer limits, the portable electric drill is used altogether for these operations; also where a true hole is required free from chatter, such as bed-plate bolts for marine engines, or column bolts which have to be reamed in place to secure a perfect fitting bolt. This is an operation that cannot be done either with a reciprocating type portable tool or by hand. The electric drill and reamer can perform this operation better because of the smooth transmission of power.

FOUR-IN-ONE DRILL-HEAD

The accompanying illustration shows the Newman quick-action four-in-one changeable drill-head arranged to accommodate four drills or other tools. It only requires a moment to change from one tool to another. This is accomplished by the instaneous release of a lock. The instant this

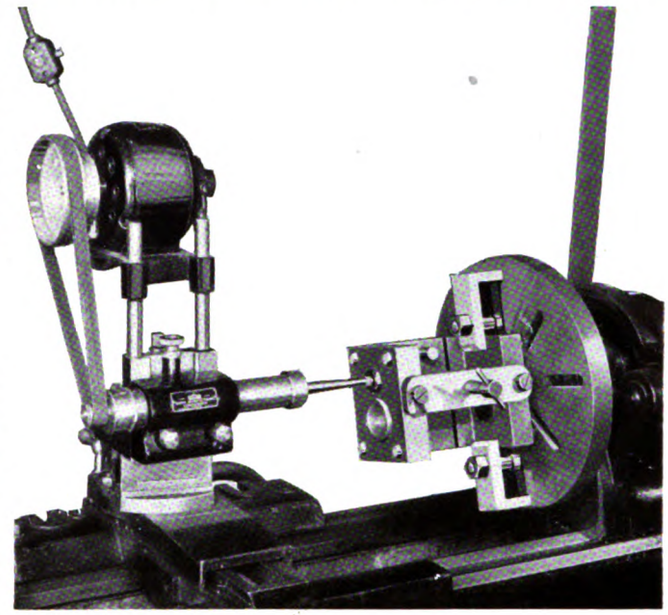


Four-in-One Drill-Head

is released, the tool in use is disconnected and another tool is switched into place, in this manner providing all the tools necessary to finish the work without stopping the machine or changing tools. The sleeve of this drill-head is attached to the rack-sleeve of the drill-press spindle and firmly clamped thereto. In other words, to adjust the drill-head to the proper height, it can be slipped up and down on the drill-press spindle and clamped thereto. Thus, the drill in use is the only one that revolves; the drill-head itself and the rest of the tools remain stationary. The F. O. Stallman Supply Co., San Francisco, is the Pacific Coast agent.

ELECTRIC TOOL-POST AND BENCH-GRINDER

The illustration shows the precision portable electric tool-post and bench-grinder manufactured by the Saphil Manufacturing Corporation, Chicago. The grinder embodies in its design and construction features that make it an all-round portable grinder adapted to production and repair



Tool-Post and Bench-Grinder

work, etc., within as close tolerances as may be required of any machine of similar capacity regardless of price, as well as the exacting requirements of tool-room service where work, perfect and free from chatter marks, is required in order to save time and produce accurate results. The grinder is shown in position on a lathe doing internal grinding. T. J. Bairnson, Pacific Bdg., Los Angeles, is the Pacific Coast representative.

NEW BENCH MACHINE FOR WOOD WORKING SHOPS

The Wallace bench saw is a bench tool, portable and designed to operate on the electric lighting circuit, yet it has ample power to take a full 2-in. cut through the hardest of wood, making it possible to use this machine for most, if not all, of the work generally done by hand or on the big circular saw in a pattern-shop. To cut at an angle the Wallace saw is tilted instead of cocking up a heavy table being required. This makes it possible to cut long stock without fear of breaking the angle by the stock coming in contact with the floor, as so often happens when long stock is cut on a table-tilting machine. Other advantages accruing from this saw-tilting design are, first: the operator is working on a table which is always in a horizontal, efficient, and safe position; second: the exact angle of cut is set without much difficulty by simply spinning the hand-wheel until the angle desired is registered on the dial in the front of the machine; third: no time is wasted adjusting the machine.

The saw can be raised and lowered so as to cut or groove the stock any depth up to 2 in. The raising and lowering mechanism is similar to the tilting mechanism and is controlled by a hand-wheel in the front of the machine. The cross-cut fence is built into the machine but can be thrown under the table when not in use. It is, however, never off the machine and lost. The rip fence is finished on both sides so that it can be used on either side of the saw. This fence is of the box type and is clamped to both sides of the

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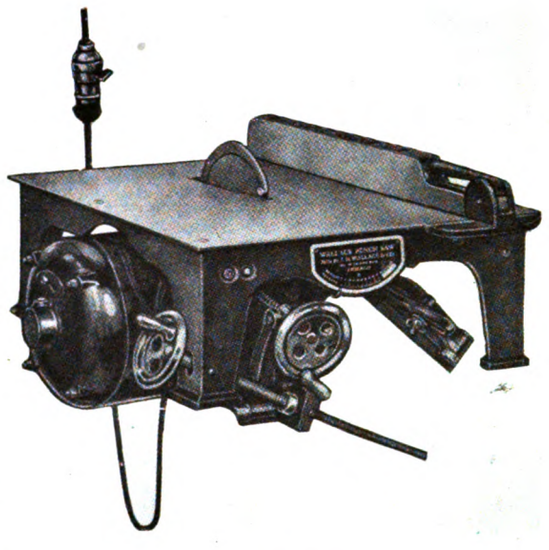
table by means of a handle conveniently placed. This handle works on an eccentric and locks by going over the centre of the eccentric. The Wallace shutter saw-guard is built into the machine. It slips back as the stock goes through and never interferes with the efficient operation of the saw. It not only protects the operator's hands, but prevents two



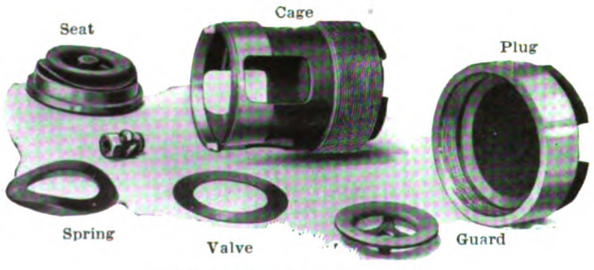
Wallace Bench-Saw

other reasons for accidents, which cause more losses than actual cutting, that of catching the tail-end of the stock in the back of the saw or catching the waste stock in the teeth of the saw and having it shoot into the abdomen of the operator. The saw is manufactured by J. D. Wallace & Co., of Chicago.

SULLIVAN 'WAFER' VALVES

Sullivan single stage belt-driven compressors, type WG-6, and the corresponding steam-driven type, 'WA-6', are now being supplied with the new improved plate valves, developed by the company's engineers at Claremont, New Hampshire works. This valve, known as the Sullivan 'Wafer' valve, is shown in the accompanying illustration. The small size, light weight, and compactness of the valve, also its spring and seat are illustrated.

The 'Wafer' valves seat in cages arranged radially to the axis of the cylinder and close to the two ends of the cylinder,



Sullivan 'Wafer' Discharge Valve

the inlet valve being situated at the bottom and the discharge valve at the top. These valves are held to their seats by flat annular springs of the same material as the valve themselves, which is the finest tempered spring steel obtainable. The valves open against specially designed guard-plates, intended to give a wide port-opening with a minimum of clearance-volume, and without restricting the admission or charge of the air to or from the cylinder. The valve, spring, and guard are easily accessible by the removal of a screw-plug.

The simple and short construction of the springs permits the valves to be placed closer to the bore of the cylinder than is generally permissible with valves of this type, with a corresponding reduction in clearance losses. The light weight of the valves and the superior quality of the material give long life. The question of repair stock is simplified because the same valves, springs, and guards are used for both inlet and discharge.

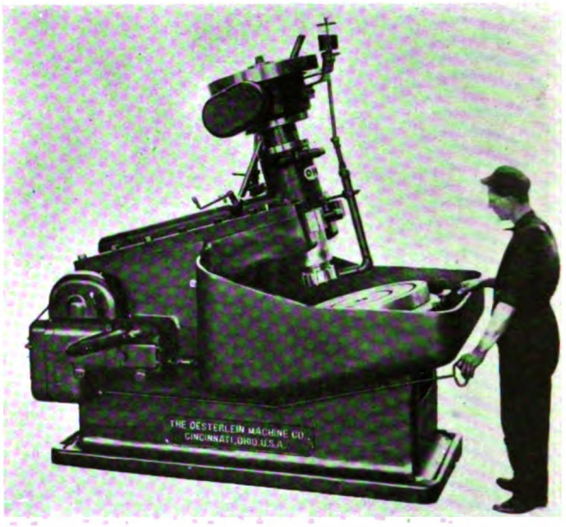
The valves are employed in multiples of relatively small size, in place of one or two valves of large diameter, the objection to the large valves being the large clearance-pockets required and the likelihood of more noisy action and greater breakage.

THE OHIO TILTED ROTARY

Certain recognized losses have retarded production on milling machines. These may be classified as follows:

1. Idle time between cuts.
2. Lack of rigidity because of the attempt at too great versatility at the expense of a multiplicity of parts.
3. Insufficient lubricant for cooling the cutters.

The time spent returning a longitudinal-feeding table, removing the finished work, clamping the new piece in the fixture and again bringing the cutter to position for cut-



The Ohio Tilted Rotary

ting, is non-productive time. On the Ohio tilted rotary there is a rotary table to carry the work to the cutting position, and during the cutting operation, work is being replaced at the opposite side of the table.

The rigidity of the machine is obtained by reducing the number of parts entering into its construction to the minimum and by the massive construction of these parts.

The body of the machine is cast in one piece. The general lines are similar to a punch-press or a shear. The working-surface of the table and the cutter-spindle are both contained in this massive casting. There is no overhang on any part of the machine, the ram bearings being extended in front so that even in the advanced position of the cutters the full length of the ram is effective. The worm-wheel is as close to the table-surface as the taper table-bearing will permit, and is bolted and pinned to the table at the extreme end of the bearing. The spindle cutters are positively driven by means of a clutch in the end of the

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spindle. A fly-wheel is mounted on the upper end of the spindle. Its momentum imparts a steady motion to the cutter.

To prevent excessive temperature-increase of the cutting tools and distortion of the work, a pump of 35 gal. per minute capacity is used. The cooling medium is raised under pressure several feet above the surface of the table and expanded into a large pipe so that it falls on the cutters and work under practically no pressure.

The mechanism necessary to provide for quick adjustment of the machine has been omitted, so that simplicity of construction and rigidity may be obtained. The machine is, therefore, a production miller applicable in a practical way only to such jobs that by reason of the quantity justify the expenditure of the 'set-up' time.

The machine when used as an indexing machine permits the use of two or more simple fixtures instead of a large one-piece fixture, holding many pieces. This feature greatly broadens the field of application and reduces the expense of tooling. By feeding the cutter radially over the surface of the table, advantage is gained in that the table is indexing while the cutter drops back to the starting position, and the radial travel eliminates cutter approach and also the non-productive time spent in passing from one piece to another on the continuous-feeding machine.

THE UNION GAS ENGINE COMPANY AEROPLANE ENGINE

An interesting comparison between the aeroplane engine manufactured by the Union Gas Engine Co. of Oakland and the famous 'Liberty' engine appeared recently in the 'Aerial Age Weekly.' The Union engine is being used by the Navy Department in both planes and dirigibles. The dirigible C-5, which was to make a trans-Atlantic flight but was blown to sea and lost, was equipped with Union engines. These made a most remarkable performance on the trip to Newfoundland, particularly in regard to gasoline consumption. The resemblances noted are all the more striking because the Union engine was designed in September 1915, two years before the Liberty engine appeared, and, so far as known, the Union engine was not considered by the designers of the Liberty engine. The connecting-rods, pistons, water-manifolds, valve-springs, valve-cooling systems, rocker-arm contact, and the ignition, lubrication, and carburetion systems in both engines are practically the same. The crank for the Liberty engine is of the seven-bearing type with hollow pins and journals. The crank for the Union engine is the same except for the addition of a radial bearing between the propeller and the thrust-bearing. With the valve mechanism of both engines the cam-shaft is placed above the centre line of the cylinder-heads. Rocker-arms differing slightly in design are used in both engines to prevent leakage of oil. The cylinders of the Liberty engine are of the steel-barrel type with steel water-jackets. There is a hold-down flange placed above the cylinder bottom. The design is the same in the Union engine, except that the valve-seats and passages are in a semi-steel head welded to the main cylinder-forging. In the Liberty engine, in order to relieve the crank-case of the tension stresses caused by cylinder explosions, the studs holding the main-bearing caps terminate at the upper end on top of the crank-case. In the Union engine, the same device is employed and in addition, studs connect through short yokes to the cylinder flanges.

Turning from general design to particular dimensions, the Union engine is of 4¾-in. bore and 6½-in. stroke, but allowance was made in the original layout for a 5 by 7-in. cylinder such as is used on the Liberty engine. Many of the dimensions of parts are identical and others differ only slightly.

Trade Notes

A bond issue of $2,500,000 has been voted at Tacoma for harbor improvements.

The California Co-Operative Canneries Corporation will construct a $250,000 cannery at Tulare.

A bond issue of $924,000 for the construction of a highway has been voted in Santa Cruz county.

The Sullivan Machinery Co. has established a new branch office at Cleveland, in charge of **Ralph T. Stone.**

The Material Handling Machinery Manufacturers Association held a convention at New York on June 11.

The trustees of the Merced high school are receiving bids for the construction of a $150,000 school building.

Construction will be commenced in July of a class A hotel-building in Fresno. The estimated cost is $550,000.

A bond issue of $2,000,000 has been voted in Fresno for the construction of school buildings in various parts of the city.

A bond issue of $1,800,000 has been voted at Sacramento for the construction of a filtration system for the municipal water-supply.

The California Peach Growers, Inc., are building a reinforced concrete and brick packing-house at Hanford. The estimated cost is $100,000.

The International Harvester Co. will construct a reinforced concrete building for its headquarters at Los Angeles. The estimated cost is $250,000.

Roy Hall, of the **Inland Iron Co.,** Fresno, has been elected to the executive committee of the American Iron and Steel and Heavy Hardware Association.

A. Mattei is having plans prepared for the construction of a 12-story reinforced concrete and steel building at J and Fresno streets, Fresno. The estimated cost is $400,000.

The Marchant Calculating Machine Co., Emeryville, reports a satisfactory and encouraging business for its machine on the east coast of South America, particularly in Brazil.

The Marine Iron Works of Astoria has commenced the construction of a marine railway at its new plant on Youngs bay. The railway will be capable of handling a 10,000-ton steamer.

C. A. Coggin, formerly sales manager of the implement department for the Baker, Hamilton & Pacific Co. has been appointed general manager for the **H. C. Shaw Co.** of Stockton.

The McKnight Fire Brick Co. of Porterville has commenced regular production. The company will produce chromite, silica, and magnesite brick, mainly from local materials.

Bond issues for highway improvement have been voted in both Fresno and Sonoma counties. The amount of the issue in Fresno county is $4,500,000, and in Sonoma county, $1,640,000.

The International Steel Co. has been organized with offices in the Old National Bank building, Spokane. It is capitalized for $500,000. The company plans to construct a rolling-mill at Spokane.

The Standard Alloy Co., with offices in the Hobart Bdg., has purchased six acres of land in South San Francisco upon which it will erect a plant for the manufacture of ferro-manganese and other alloys.

At the convention of the Boilermakers Supply-Men's Association at Chicago, the **Independent Pneumatic Tool Co.** exhibited its 'Thor' line of equipment, including chipping-hammers, riveting-hammers, and drills.

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The City of Berkeley has leased its entire waterfront for a term of 50 years to **Rufus P. Jennings**, of Oakland. The terms of the lease call for an expenditure of at least $1,000,000 upon the property. Mr. Jennings has control of a large body of adjacent waterfront property, and is reported to be preparing plans for development similar to that of the Bush Terminal, at Brooklyn.

H. L. Garbutt, for the last six years manager of the line-material section for the **Westinghouse Electric & Manufacturing Co.,** has been appointed manager of the supply division of the company's San Francisco office.

Plans are now under way for a 'Safety-First' campaign in San Francisco and the vicinity. The committee in charge is composed of **J. J. Tynan,** chairman; **J. H. Colton, T. B. W. Leland, Warren H. McBryde,** and **C. R. Johnson.**

Bond issues amounting in all to $5,000,000 were voted for highway construction in various counties in Oregon during the month of June. A State issue of $2,500,000 for the construction of the Roosevelt highway was also approved.

Contract for construction of a hydro-electric plant at Caribou, on the north fork of the Feather river, for the **Great Western Power Co.** has been awarded to **Stone & Webster.** The total estimated cost of the project is $6,000,000.

M. McDiarmid, E. H. Carr, and **A. L. McQuarrie** have organized the **Stockton Farm Machinery Co.,** with headquarters at Stockton. The company will handle general farm machinery, including the Fairbanks-Morse line of engines, pumps, and other equipment.

R. C. Monteagle, president and general manager for the Pacific Construction & Engineering Co. of Seattle, sailed early in June on a several months trip through the Orient and Australia. He will make a special study of trade conditions and opportunities on behalf of the industries of Washington.

The United American Trading Co. has opened offices in the Mills building, with **Eugene S. Selvage** as general manager. The company will make a specialty of the importation of vegetal-oils, copra, and beans from the Orient and the exportation of iron, steel, hardware, machinery, and chemicals.

An **American Chamber of Commerce** has been formed at Valparaiso for the purpose of promoting trade relations between merchants of Chile and the United States. The officers are: president, Rea Hanna; secretary, Edwin C. Schmidt. The chamber would like to receive American trade publications and catalogues.

Vladimir, Bogolepoff & Co., of Vladivostok, who have branches in other cities of Siberia, have established headquarters for the United States in the Flood building, San Francisco. S. G. Finn, general manager for the firm, reports that there is a large demand for American goods in all parts of Russia and Siberia.

Herberts Machinery & Supply Co., 168 Second street, announces that on July 1, it will take on the exclusive selling agency of the Foster Machine Co., Elkhart, Indiana. This company manufactures screw-machines, turret-lathes, brass-lathes, and universal turrets. The Herberts company now has the exclusive agency for the whole State for all the lines it handled in the Los Angeles territory.

The United Products & Sales Corporation, San Francisco, has just put on the market a remarkable grease manufactured from mineral oils. This grease will stand a high temperature without being affected and maintains a film between wearing parts under great compression. It has proved satisfactory for plug-valves at the plant of the Pacific Gas & Electric Co., where the grease has to stand a temperature of 350°F. On gears it has also proved satisfactory, as it not only sticks but in a measure acts as a silencer. One dealer in second-hand automobiles uses this grease on the transmissions of the cars he sells, as it eliminates a great deal of the noise from the worn gears. The manufacturer has tested the grease under many different conditions for over a year and states that it has not failed once.

Machinery that heretofore has been used almost entirely in the recovery of minerals from their ores is now being applied by the **National Smelting Corporation** for the reclamation of the metallic contents of foundry dirt, ashes, cinders, etc. In the concentration plant, a view of which is shown in the company's advertisement in this issue, a large quantity of this type of machinery is used, including specially constructed grinders, classifiers, jigs, elevators, and a Deister-Overstrom sand table, as well as pumps, water-tanks, aerators, and settlers. All the operations in this plant except the initial feeding is done automatically; only two men are required to treat 25 tons per day. Floor sweepings, tumbler-barrel mud, emery grindings, broken crucibles, skimmings, oxidized metals, sawings, and other metallic residues are reclaimed in this plant, which can operate successfully on material containing as low as 3% metal. A market has been created for much material which formerly had to be carted to the dump at considerable expense.

Physical tests recently made on **Titanic babbitt,** a new bearing metal put out by the National Smelting Corporation, show its properties to be similar to genuine babbitt formula, although it is an alloy of lower-priced metals. The results of the test are as follows:

Tensile strength, pounds per square inch	9,800
Yield point, pounds per square inch	2,100
Elongation, per cent	3
Compression yield point, pounds per square inch	11,100

At 21,500 pounds per square inch, failure commenced. This load was maintained with a yield of 0.525 in. The final breaking load was 41,100 lb. per square inch. After fracturing at 41,100 lb. the piece flattened to 0.285 in. thick by 2 in. square. Melting point, 461°F. Brinell hardness, 21.

Market Review

General improvement in the metal markets is noted throughout the country. Consumers, who have delayed coming into the market in the hope of further price reductions, have now become convinced that any further reductions will be small and may be delayed for a long time, possibly even years. Indeed it is by no means certain that prices may not advance, for a time at least. In the East, the prices 'suggested' by the ill-fated Industrial Board for semi-finished and finished product continue to be the ruling figures, and there is less inclination than a month ago to shade these prices on large orders. Some reductions have been made on certain grades of pig-iron.

The local market reflects the general improvement. The price schedule remains unchanged both for warehouse and for mill deliveries, but there are fewer instances of reductions to obtain a large order than hitherto. One jobber reports more business during June than during the three preceding months. Another indication of reviving business is found in the fact that one large consumer, who has been out of the market entirely for several months, is sending out inquiries for 500 tons of material.

A good local demand is reported for scrap. The price of cast-iron scrap is unchanged but demand has increased considerably and the visible supply is relatively small. Steel scrap has stiffened and is now selling at $18 per gross ton. Sales are reported at Eastern points as high as $22.

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